A PENTON PUBLICATION U.S. $10.00

ELECTRONIC DESIGN

13 APR 1994

JANUARY 10, 1994

FOR ENGINEERS AND ENGINEERING MANAGERS—WORLDWIDE

SILICON CHIP SET BRINGS 100-MBIT/S DATA TO THE DESKTOP

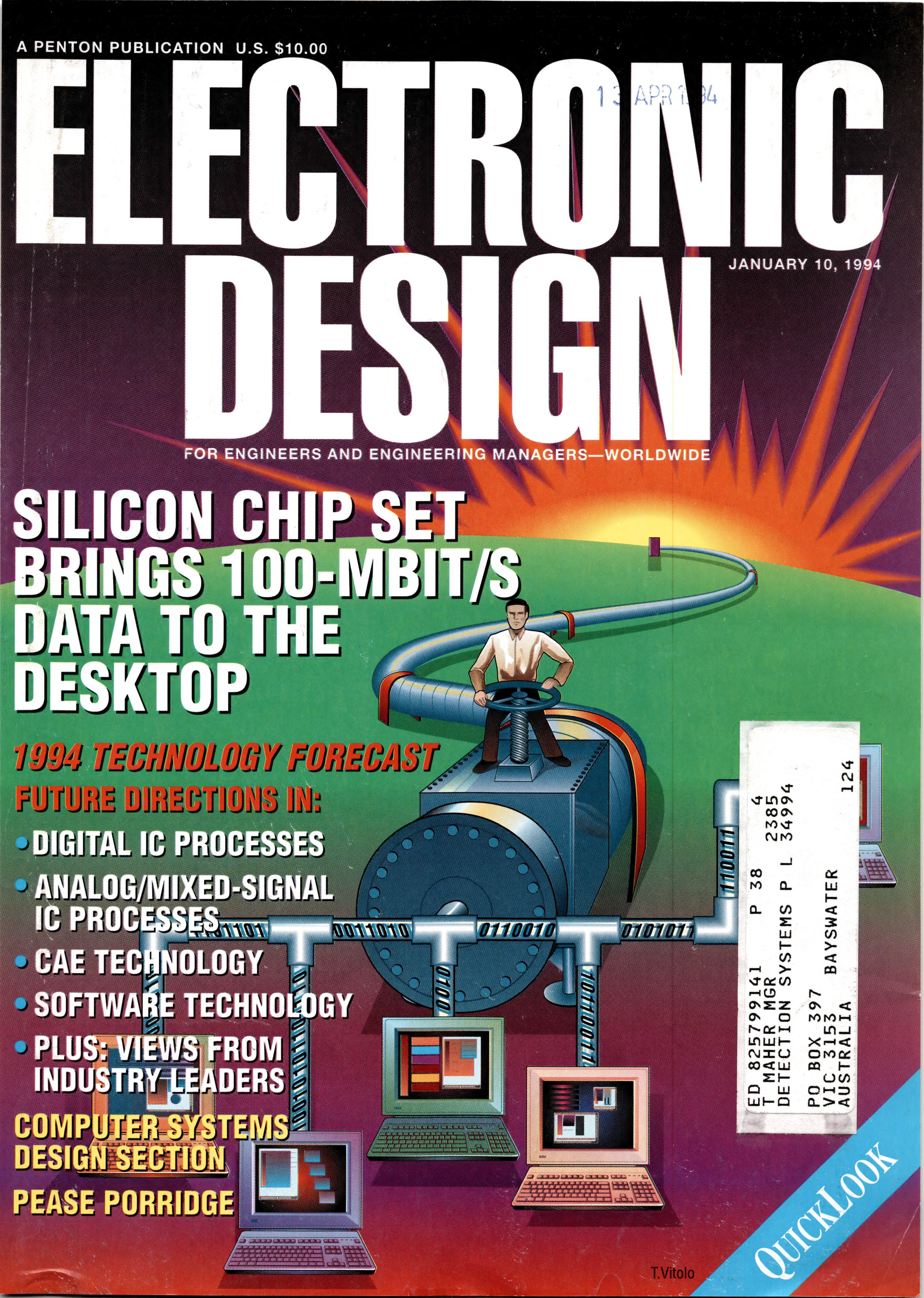
1994 TECHNOLOGY FORECAST

FUTURE DIRECTIONS IN:

- DIGITAL IC PROCESSES
- ANALOG/MIXED-SIGNAL IC PROCESSES
- CAE TECHNOLOGY
- SOFTWARE TECHNOLOGY
- PLUS: VIEWS FROM INDUSTRY LEADERS

COMPUTER SYSTEMS DESIGN SECTION

PEASE PORRIDGE



T.Vitolo

ED 825799141 P 38 4
T MAHER MGR 2385
DETECTION SYSTEMS P L 34994

PO BOX 397
VIC 3153 BAYSWATER
AUSTRALIA 124

QUICKLOOK

Theirs

- ☐ Virtually unlimited capacity.
- ☐ 32 layer definitions.
- ☐ 16 routing layers.
- ☐ Assignable Power and Ground layers.
- ☐ Copper pour for copper zones.
- ☐ All object, on line editing. (Point and edit.) (Apply edit uniquely, locally, or globally.)
- ☐ Compound pad stacks with full rotation.
- ☐ Ability to import sections of existing boards for new design.
- ☐ Automatic footprint generators.
- ☐ Delete and undelete for all objects in the data base.
- ☐ Over 1,000 footprints. (All SMT Manual footprints.)
- ☐ Ability to create multipackage interconnected modules.
- ☐ Full dimensioning capability.
- ☐ All angle on or off grid manual routing with visual copper spacing.
- ☐ Arcs and circles for traces and outlines.
- ☐ Move, drag and place with 0.01 degree rotation resolution.
- ☐ Full support for release to manufacturing.
- ☐ **High quality autorouter, 16 layers simultaneously.**

$10,000+

OrCAD®

- ☑ Virtually unlimited capacity.
- ☑ 32 layer definitions.
- ☑ 16 routing layers.
- ☑ Assignable Power and Ground layers.
- ☑ Copper pour for copper zones.
- ☑ All object, on line editing. (Point and edit.) (Apply edit uniquely, locally, or globally.)
- ☑ Compound pad stacks with full rotation.
- ☑ Ability to import sections of existing boards for new design.
- ☑ Automatic footprint generators.
- ☑ Delete and undelete for all objects in the data base.
- ☑ Over 1,000 footprints. (All SMT Manual footprints.)
- ☑ Ability to create multipackage interconnected modules.
- ☑ Full dimensioning capability.
- ☑ All angle on or off grid manual routing with visual copper spacing.
- ☑ Arcs and circles for traces and outlines.
- ☑ Move, drag and place with 0.01 degree rotation resolution.
- ☑ Full support for release to manufacturing.
- ☑ **High quality autorouter, 16 layers simultaneously.**

$2,495

The choice is clear.

For your free demo disk of OrCAD's new PCB 386+ design tool, call 503-671-9500 today. OrCAD Europe 33-1-45 75 50 00

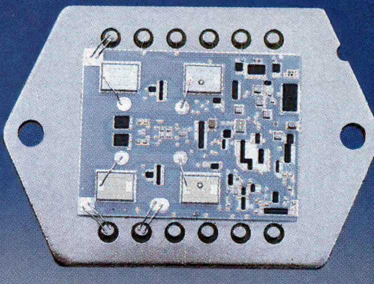
OrCAD®

The leader in board design tools for the PC

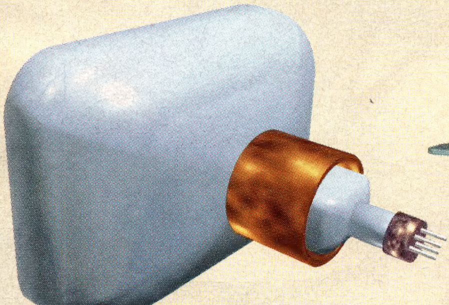
CIRCLE 196 FOR U.S. RESPONSE CIRCLE 197 FOR RESPONSE OUTSIDE THE U.S.

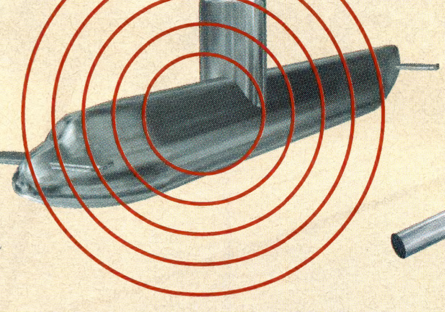
ROBOTICS AIRCRAFT TEST EQUIPMENT ATE

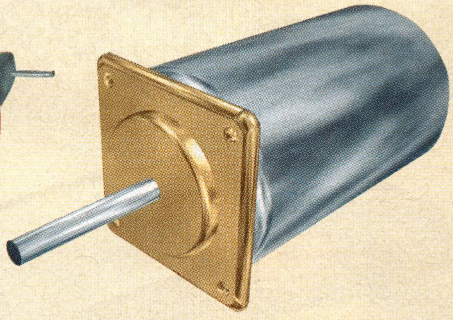
Simplify Your Power Amp Designs



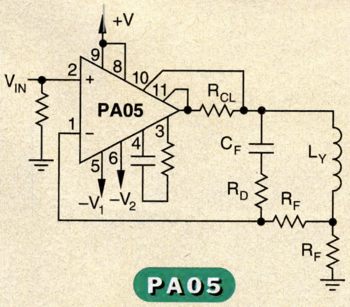
If your application requires a high power operational amplifier, Apex has more than 32 models to help you save design time and build in reliability. Output current ranges vary from 5A up to 50A continuous. Most models also feature MOSFET technology and thermal protection for increased reliability by eliminating second breakdown. Apex Applications Engineers can address your specific design and help with product selection. Call toll-free **800-862-1021**, or **FAX 1-602-888-3329.**







DEFLECTION

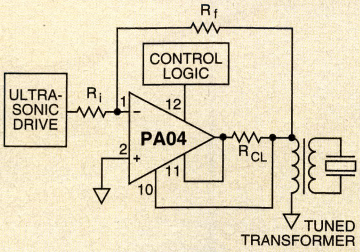


PA05

High Speed, High Power Bandwidth

- Slew Rate 100V/µs
- I_O = ±30A
- V_{SS} = 30V-100V
- 360kHz power bandwidth

SONAR

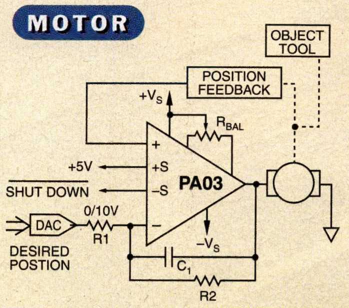


PA04

High Voltage, High Speed

- V_{SS} = 30V-200V
- I_O = ±20A
- Slew Rate 50V/µs
- 90kHz power bandwidth

MOTOR



PA03

High Power, High Internal Dissipation

- I_O = ±30A
- 500W internal power dissipation
- V_{SS} = 30V-150V
- 30kHz power bandwidth

For Immediate
Product Information,
or to Place an Order
Call **1-800-862-1021**
or FAX **(602) 888-3329**

APEX µtech®
DEDICATED TO EXCELLENCE

APEX MICROTECHNOLOGY CORPORATION
5980 N. SHANNON ROAD, TUCSON, ARIZONA 85741

For Applications
Assistance Call Toll
Free **1-800-862-1021**
or FAX **(602) 888-7003**
Deutsch Gesprochen
0130 81 3599

***AUSTRALIA, NEW ZEALAND** (08) 277 3288 **BELGIUM/LUXEMBOURG** (03) 458 3003 **CANADA** (416) 821 7800 **DAEHAN MINKUK** (02) 745 2761 **DANMARK** (45) 97 25 0816 **DEUTSCHLAND** (6172) 5113 **ESPAÑA** (1) 530 4121 **FRANCE** (1) 69 07 08 24 **HONG KONG** 8339013 **HUNGARY/CZECH** (36) 1 1762 783 **INDIA** (212) 339836 **ISRAEL** (3) 9345171 **ITALIA** (2) 99041977 **NEDERLAND** (10) 451 9533 **NIPPON** (3) 3244-3787 **NORGE** (2) 50 06 50 **ÖSTERREICH** (222) 505 15 220 **PEOPLES REPUBLIC OF CHINA** (86) 500 7788 **REPUBLIC OF SOUTH AFRICA** (021) 24-4071 **SCHWEIZ** (56) 21 67 21 **SINGAPORE** (65) 741 8966 **SUOMI** (0) 522 122 **SVERIGE** (8) 795 9650 **TAIWAN—REPUBLIC OF CHINA** (02) 729 6139 **TURKIYE** (1) 337 22 45 **UNITED KINGDOM** (844) 278781*

CIRCLE 224 FOR U.S. RESPONSE **CIRCLE 225 FOR RESPONSE OUTSIDE THE U.S.**

New Wave Memories

16M Synchronous DRAMs

Forget about cost/performance trade-offs. Our new 16M Synchronous DRAMs give you big benefits in both areas. Operating at 100MHz clock, they eliminate CPU wait states. So workstation designers save by eliminating costly cache SRAMs. And PC designers gain a quantum leap in system speed.

Our new 16M Synchronous DRAMs provide a minimum cycle time of 10 nanoseconds (100MHz) and a maximum data transfer rate of 200M bytes per second (x16 device) with a 3.3V power supply. They're designed with 3-level pipeline architecture and 0.5-micron CMOS technology. Other features include:

- ☐ Full JEDEC compatibility
- ☐ Programmable mode register for burst length, wrap type and $\overline{\text{CAS}}$ latency
- ☐ Dual memory banks for ping-pong operation
- ☐ Clock suspend and power-down operation

To meet your system needs, our 16M Synchronous DRAMs are available in a variety of speeds and organizations. Clock-speed versions are 66, 75, 83, and 100MHz. Bit organizations are x4, x8 and x16. Package types are 44-pin or 50-pin 400mil TSOPII.

Breaking cost/performance barriers—that's what new wave memories are all about. To receive more information about our 16M Synchronous DRAMs, or to order your samples, call NEC today.

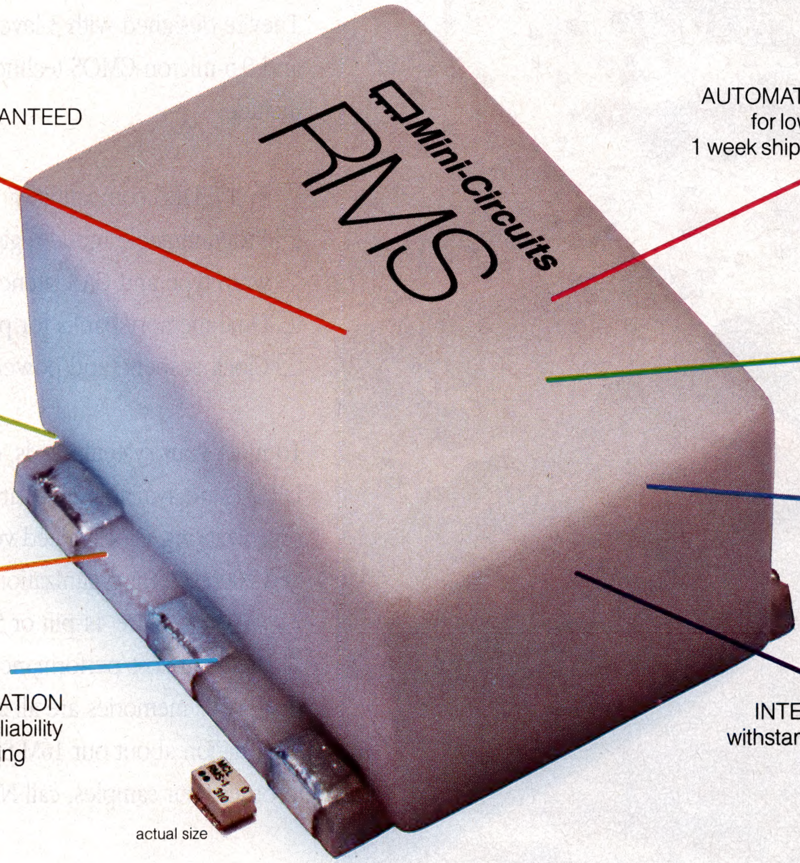
From the leader in memory technology

For fast answers, call us at: USA Tel:1-800-366-9782. Fax:1-800-729-9288. Germany Tel:0211-650302. Fax:0211-6503490. The Netherlands Tel:040-445-845. Fax:040-444-580. Sweden Tel:08-753-6020. Fax:08-755-3506. France Tel:1-3067-5800. Fax:1-3946-3663. Spain Tel:1-504-2787. Fax:1-504-2860. Italy Tel:02-6709108. Fax:02-66981329. UK Tel:0908-691133. Fax:0908-670290. Ireland Tel.01-6794200. Fax:01-6794081. Hong Kong Tel:886-9318. Fax:886-9022. Taiwan Tel:02-719-2377. Fax:02-719-5951. Korea Tel:02-551-0450. Fax:02-551-0451. Singapore Tel:253-8311. Fax:250-3583. Australia Tel:03-8878012. Fax:03-8878014. Japan Tel:03-3454-1111. Fax:03-3798-6059.

CIRCLE 140 FOR U.S. RESPONSE

CIRCLE 141 FOR RESPONSE OUTSIDE THE U.S.

MIXERS UNPRECEDENTED IN VALUE.



Mini-Circuits
RMS
4.5 SIGMA REPEATABILITY GUARANTEED
AUTOMATED ASSEMBLY for low-cost and 1 week shipment guaranteed
ALL-CERAMIC PACKAGE cover pull strength in excess of 20 lbs.
ULTRA•REL™ MIXERS 5 YEAR GUARANTEE
RUGGED CONSTRUCTION passes MIL-M-28837 shock and vibration tests
SURFACE MOUNT board area .25 x .30" tape and reel available
SOLDER PLATE OVER NICKEL METALIZATION improves solder reflow reliability and eliminates leaching
ALL-WELDED INTERNAL CONSTRUCTION withstands up to 240°C for 5 minutes
actual size

ALL-CERAMIC 5 to 3000MHz from 3^{95} (10-49 qty)

Now you can buy very low-cost, high-performance commercial mixers with the ruggedness and reliability required for military applications. That's value! ...Only from Mini-Circuits.

Model	LO (dBm)	Freq. (MHz) LO,RF	IF	Midband, dB Conv. Loss	Isol L-R	L-I	$ ea. (10-49)
RMS-11X	+7	5-1900	5-1000	7.1	29	31	3.95
RMS-11F	+7	350-2000	DC-400	5.5	31	30	4.95
RMS-30	+7	200-3000	DC-1000	6.5	26	22	6.95
RMS-25MH	+13	5-2500	5-1500	7.5	32	32	7.95

finding new ways ...
setting higher standards

Mini-Circuits®

WE ACCEPT AMERICAN EXPRESS AND VISA

P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661

Distribution Centers / NORTH AMERICA 800-654-7949 • 417-335-5935 Fax 417-335-5945 EUROPE 44-252-835094 Fax 44-252-837010

For detailed specs on all Mini-Circuits products refer to • THOMAS REGISTER Vol. 23 • MICROWAVES PRODUCT DIRECTORY • EEM • MINI-CIRCUITS' 740-pg HANDBOOK.

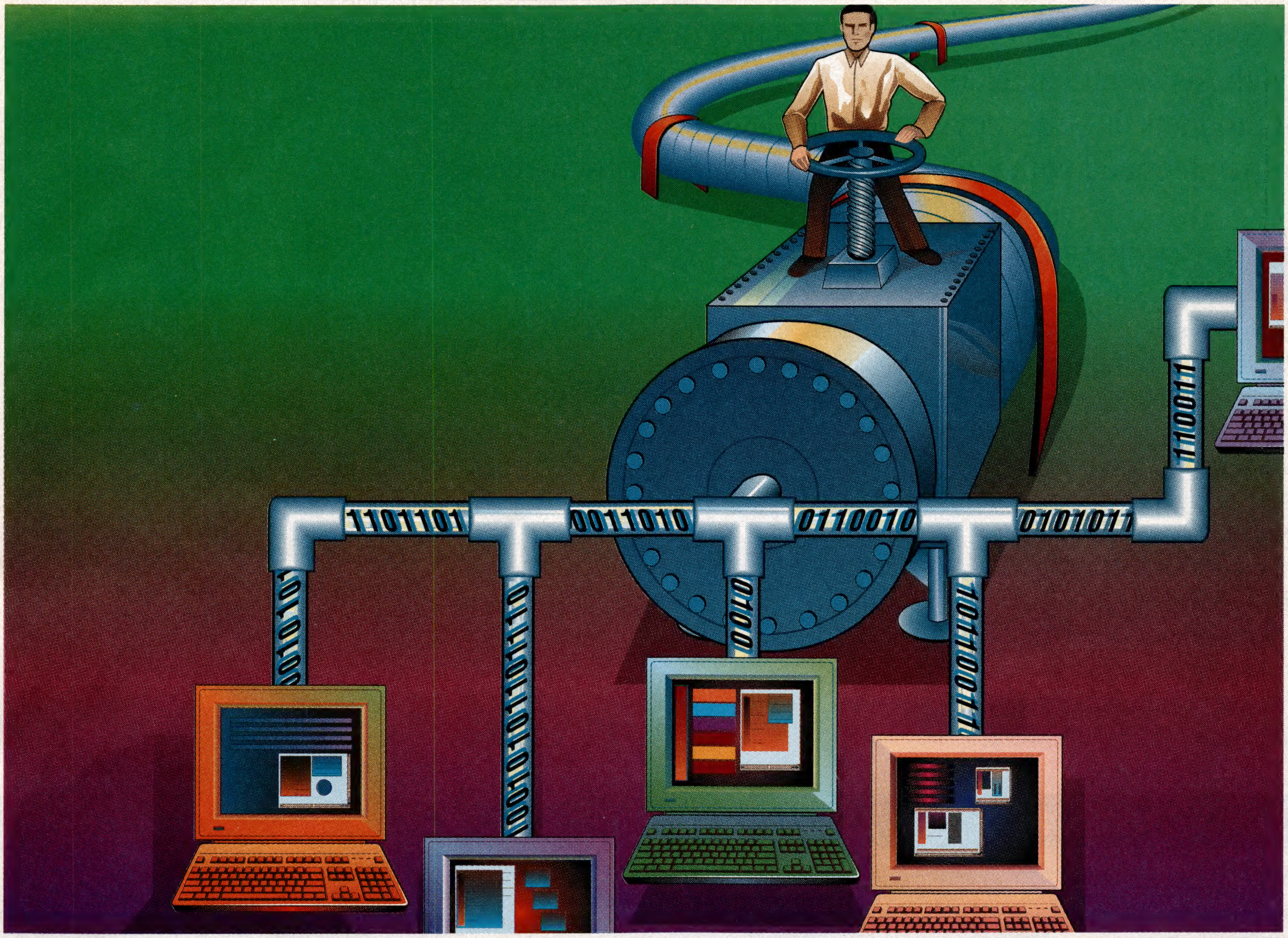
CUSTOM PRODUCT NEEDS... ***Let Our Experience Work For You.***

F166 REV. ORIG.

CIRCLE 285 FOR U.S. RESPONSE **CIRCLE 286 FOR RESPONSE OUTSIDE THE U.S.**

JANUARY 10, 1994 VOL. 42, NO. 1

ELECTRONIC DESIGN



COVER FEATURE

CHIP SET DELIVERS 100 MBITS/S TO THE DESKTOP . . . 45
By dividing a 100-Mbit/s data stream into four 25-Mbit/s streams, a chip set for 100Base-VG networks trims connectivity cost.

1994 TECHNOLOGY FORECAST

INTRODUCTION . . . 57
Future developments in digital process technology, analog and mixed-signal process technologies, electronic design automation, and software development are previewed.

MILLION-GATE ASICS TO PROVIDE SYSTEMS ON-A-CHIP . . . 59
Complex systems are demanding custom or ASIC solutions.

SIGE, SOI TO LEAD ANALOG, MIXED-SIGNAL PROCESSES . . . 69
SiGe ICs will give GaAs devices a run for their money.

PROCESS MANAGEMENT WILL TAP EDA PRODUCTIVITY . . . 80
Managing EDA tools and data in a unified flow will challenge engineers.

THE DRIVE TO STREAMLINE SOFTWARE DEVELOPMENT . . . 89
Design teams aim to keep pace by working smarter.

INTERVIEW SECTION . . . 99
Eight industry experts look ahead to the coming year's developments.

DESIGN COMPLEX PLDS WITHOUT LEAVING YOUR SYSTEM BEHIND

PLSyn is the most advanced desktop programmable logic synthesis system available. Part of the **Design Center** family of products, it offers device-independent logic synthesis fully integrated with a mixed-signal design environment.

DESIGN YOUR SYSTEM...

PLSyn lets you concentrate on your system, not on the PLDs. It is the only desktop system that allows you to design and simulate a system containing programmable logic, discrete digital, and analog parts all on the same schematic. You can describe your logic using a powerful synthesis language, logic symbols, or a combination of both. Programmable logic is automatically compiled and simulated with the rest of your system—even if it includes analog! You no longer need to piece together separate programmable logic, discrete logic, and analog simulations to be sure your system will work.

...THEN CHOOSE THE PARTS

When logic design is complete, PLSyn helps you find the best parts to use. You define your own goals for price, speed, and power consumption. PLSyn does the rest. It searches a library of over 4,000 devices, including the new large complex PLDs from AMD and others. PLSyn can even automatically partition your design into several different types of parts to meet your design goals. Whether you are new to programmable logic, or an experienced PLD user, the **Design Center**'s PLSyn is your most productive programmable logic design system. Call today for more information!

MicroSim Corporation

Providing the Best in Desktop EDA

20 FAIRBANKS • IRVINE, CA 92718 • USA
(714) 770-3022 • (800) 245-3022
FAX: (714) 455-0554 • BBS: (714) 830-1550

SCHEMATIC CAPTURE — MIXED-SIGNAL SIMULATION — DIGITAL SIMULATION — ANALOG SIMULATION — SIGNAL INTEGRITY — PROGRAMMABLE LOGIC SYNTHESIS

Design Center and PSpice are registered trademarks of MicroSim Corporation. All other trademarks are the property of their respective owners.

• CIRCLE 305 FOR IBM • CIRCLE 306 FOR SPARCSTATION

40
YEARS
OF EDITORIAL
EXCELLENCE

40 YEARS AGO IN ELECTRONIC DESIGN . . . 8

Remote helicopter autopilot; junction transistors with 40% smaller cases

READER'S COMMENTS . . . 16

EDITORIAL . . . 18

A brighter forecast for '94

TECHNOLOGY BRIEFING . . . 22

CBiCMOS tunes up mixed-signal ICs

TECHNOLOGY NEWSLETTER . . . 27

- Field-emission scheme yields color panels
- MCC launches study of opto interconnects
- Process produces near-photographic quality
- Motorola licenses its ball-grid-array package
- APM specification gets revised
- Wafer-scale designs focus on practicality
- Interface spec links models to simulators
- Object-oriented OS empowers app creation

TECHNOLOGY ADVANCES . . . 35

- Interpreter bridges software to VME
- High-density DRAMs, fast 64-bit processors, and communications ICs take the spotlight at ISSCC
- Digital-control scheme removes CRT distortion
- Crosspoint switch architecture boosts multiprocessor performance

Jesse H. Neal Editorial Achievement Awards:
1967 First Place Award
1968 First Place Award
1972 Certificate of Merit
1975 Two Certificates of Merit
1976 Certificate of Merit
1978 Certificate of Merit
1980 Certificate of Merit
1986 First Place Award
1989 Certificate of Merit
1992 Certificate of Merit

Cover Illustration: Tony Vitolo

QUICK LOOK . . . 112A

- Perspectives on Time-to-Market
- Sales of fax units keep going strong
- Eye on ISO 9000
- Hot PC products

IDEAS FOR DESIGN . . . 117

- Correct V_{os} with no extra parts
- Analog switch uses single supply
- Get absolute temp log with RS-232

PEASE PORRIDGE . . . 123

What's all this management stuff, anyhow?

COMPUTER SYSTEMS SPECIAL SECTION

PC Graphics Watch . . . 127
Embedded designs follow CPU curve . . . 129
System Design News . . . 134
System Design Products . . . 136

PRODUCT NEWSLETTER . . . 141

- FDDI chip set trims price by 40%
- Price drops for FPGAs ease military budgets
- One-chip ENDEC trims network adapter cost
- Ready works with AMD 29-k family
- Chip puts interaction and multimedia on TV

NEW PRODUCTS

Digital ICs . . . 144
Computers & Peripherals . . . 146
Instruments . . . 148
Communications . . . 154
CAE . . . 156
Software . . . 158
Analog . . . 162

NEW LITERATURE . . . 164

INDEX OF ADVERTISERS . . . 168

READER SERVICE CARD . . . 169

COMING NEXT ISSUE

- Special Report: Optical storage devices
- A preview of the Portable By Design conference
- A new high-speed, 10-bit, low-power analog-to-digital converter
- Special Section: PIPS: Power, Interconnections, Passives, Switches and Relays
- Pitfalls in designing power supplies for portable systems
- Manufacturers listing of power-supply vendors
- First details on a new PCI-compatible peripheral controller
- Testing Sonet systems
- PLUS:

Pease Porridge
Ideas for Design
Quicklook

ELECTRONIC DESIGN (USPS 172-080; ISSN 0013-4872) is published semi monthly except for 3 issues in May and 3 issues in October by Penton Publishing Inc., 1100 Superior Ave., Cleveland, OH 44114-2543. Paid rates for a one year subscription are as follows: $105 U.S., $185 Canada, $210 Mexico, $255 International. Second-class postage paid at Cleveland, OH, and additional mailing offices. Editorial and advertising addresses: ELECTRONIC DESIGN, 611 Route #46 West, Hasbrouck Heights, NJ 07604. Telephone (201) 393-6060. Facsimile (201) 393-0204.

Printed in U.S.A. Title registered in U.S. Patent Office. Copyright © 1994 by Penton Publishing Inc. All rights reserved. The contents of this publication may not be reproduced in whole or in part without the consent of the copyright owner.

Permission is granted to users registered with the Copyright Clearance Center Inc. (CCC) to photocopy any article, with the exception of those for which separate copyright ownership is indicated on the first page of the article, provided that a base fee of $1 per copy of the article plus $.50 per page is paid directly to the CCC, 222 Rosewood Drive, Danvers, MA 01923 (Code No. 0013-4872/93 $1.00 + .50). (Can. GST #R126431964). Canada Post International Publications Mail (Canadian Distribution Sales Agreement Number 344117). Copying done for other than personal or internal reference use without the express permission of Penton Publishing, Inc. is prohibited. Requests for special permission or bulk orders should be addressed to the editor.

For subscriber change of address and subscription inquiries, call (216) 696-7000.

Mail your subscription requests to: Penton Publishing Subscription Lockbox, P.O. Box 96732, Chicago, IL 60693.

POSTMASTER: Please send change of address to ELECTRONIC DESIGN, Penton Publishing Inc., 1100 Superior Ave., Cleveland, OH 44114-2543.

FAST
CMOS
FLASH A/Ds

Micro Networks Can Solve Your Application Puzzle with the Industry's Fastest CMOS Flash A/D Converters.

MN5909
100MHz
34dB SINAD
43dB SFDR
200mW Power

MN5906
50MHz
35dB SINAD
44dB SFDR
225mW Power

FEATURES

- 6-Bit Resolution
- +5V Supply Operation
- T/H Not Required
- DIP and SOIC Packaging
- Commercial, Industrial and Military Models

Call or FAX for FREE Samples or Product and Applications Information for Our CMOS Flash A/D Converters.

Maximum Performance Minimum Power

Micro Networks is an ISO-9001 "Registered Firm"

nsai
I.S./ISO 9001/EN 29001

MICRO NETWORKS
324 Clark Street
Worcester, MA 01606
Tel (508) 852-5400
Fax (508) 853-8296

CIRCLE 128 FOR U.S. RESPONSE
CIRCLE 129 FOR RESPONSE OUTSIDE THE U.S.

ELECTRONIC DESIGN 40 YEARS AGO

Remote Helicopter Autopilot

A completely automatic method for maintaining a helicopter in a hovering position directly above a given point on the ground and at a given altitude was demonstrated recently at Patrick Henry Airport, Warwick, Va. The method employed is entirely automatic and does not require operators at any point in the system to enable the helicopter to maintain its horizontal position directly above a selected point to an accuracy of better than five feet.

The new system, jointly demonstrated by the Hastings Instrument Corp. and Raydist Navigation Corp., both of Hampton, Va., and the Piasecki Helicopter Corp., Morton, Pa., comprises a closed-link system consisting of "Raydist" (a continuous wave radio location system), an autopilot, and a Piasecki-built HUP-2 twin rotor helicopter. The plane was controlled in flight with equal accuracy at low and high altitudes.

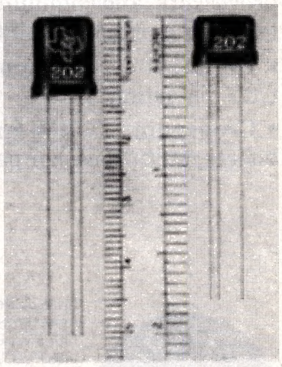
Taking off first on automatic position, the helicopter then ascended to an altitude of 1100 feet. At this height, it maintained a stable hover for about seven minutes, according to the strip chart records of the operation. The helicopter also descended by means of the Raydist-controlled automatic pilot and was landed within one or two feet of the central point, demonstrating the repetitive capacity of the system.

The operation utilized a small transmitter installed in the helicopter. Signals from two Raydist relay stations on the ground were compared in one phase meter to indicate longitudinal movements of the helicopter. Simultaneously, signals from two other relay stations were compared in a second phase meter to indicate the transverse movement. The transducer unit employed for each of these error indications was a small low-torque potentiometer attached to the shaft of the respective phase meters. Whenever the helicopter drifted to the right or left of the reference point, the transverse phase meter indicated the movement as rotation. This actuated the arm of the potentiometer and introduced positive or negative signals to the autopilot. Reacting to these signals, the autopilot then adjusted the cyclic pitch of the rotor blades to reposition the helicopter and bring the phase meters back to the null position. Fore and aft digressions were handled in a similar manner. This Raydist controlled autopilot combination promises to make automatic helicopter navigation and landing extremely practical. *(Electronic Design, January 1954, p. 10.)*

It's odd that this article doesn't mention the frequency band of operation. Could that have been classified information in the 1954 cold-war days?—SS

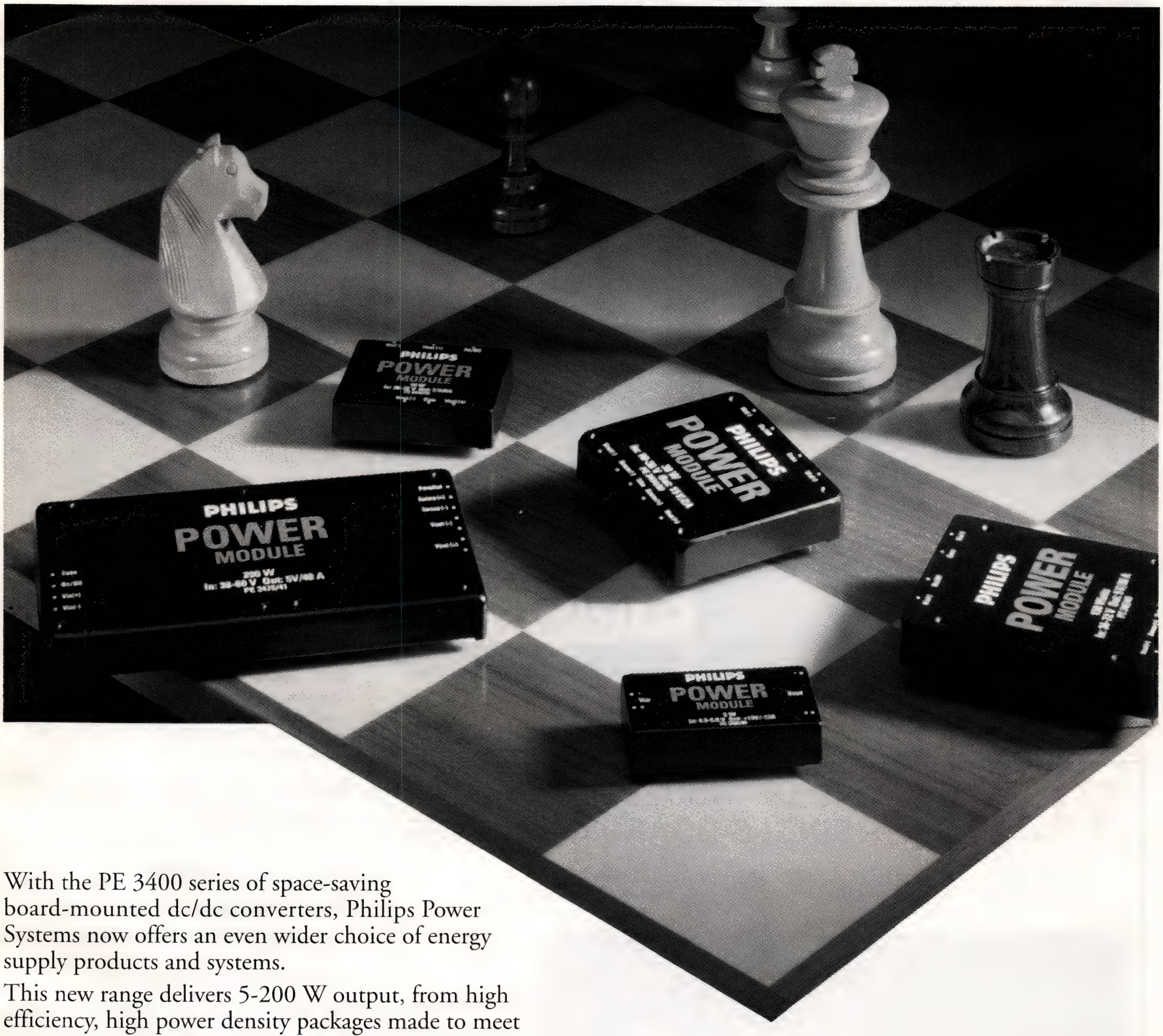
Junction transistors with 40% smaller cases

The cases of the n-p-n grown junction transistors produced by Texas Instruments have been reduced 40% by changing the length dimension form 0.500" to 0.300". Connections are made to the case through three leads, supplied already tinned and 1-1/2" long, suitable for soldering into the circuit or clipping to desired length and plugging into a subminiature socket. The cut in case size affects only the case length. No other change was made in materials or fabrication methods; the moisture-proof, glass-to-metal hermetic sealing and electrically insulating finish remain unchanged. The transistors are available in three types, differing principally in collector resistance and amplification factor. Alpha (current amplification factor) is a guaranteed minimum of 0.90 in Type 200, 0.95 in Type 201, and 0.98 in Type 202 transistors. Texas Instruments, Inc., Dept. ED, 6000 Lemmon Ave., Dallas 9, Texas. *(Electronic Design, January 1954, p. 29.)*



According to Electronic Design's Second Annual Transistor Data Chart (July 1954), these germanium devices were TI's first commercial transistors. Later in 1954, TI developed a process for growing single-crystal silicon and began offering silicon diodes. Silicon transistors followed in 1955.—SS

We've taken your dc/dc needs on board



With the PE 3400 series of space-saving board-mounted dc/dc converters, Philips Power Systems now offers an even wider choice of energy supply products and systems.

This new range delivers 5-200 W output, from high efficiency, high power density packages made to meet your toughest applications.

Fixed frequency 500 kHz soft switching and a special planar transformer design cut power losses, reduce component stress and eliminate the need for filtering. The result is outstanding efficiency — 84% at 5 V/30 A — and MTBF better than 1 million hours.

SMD construction on metal board substrates ensures optimal thermal management, minimising the need for external heat-sinks. And maximum permitted case temperature is a high 100°C.

Up to 1.5 kV input/output isolation permits flexible polarity configuration and earthing connection — while remote sensing, remote on/off and optional built-in control for n+1 redundancy make these converters ideal for use in distributed power systems. All units are UL and CSA approved.

▶ **Philips — for performance in power**

For more information:

Philips Power Systems
Boulevard de l'Europe 131
B-1301 Wavre, Belgium
Tel: (+32) 10 43 85 02 Fax: (+32) 10 43 82 13

Philips
Power
Systems

PHILIPS

Circle 177

SCSI PORTABLE ANALYZER / EMULATOR

- SCSI 1&2
- SCSI 3 Parallel
- FAST & WIDE
- SCSI Initiator Emulator
- Single-Ended or Differential (optional)
- Tracing over 10Mhz with 20 nsec time stamp resolution
- Applications: development, production, field service

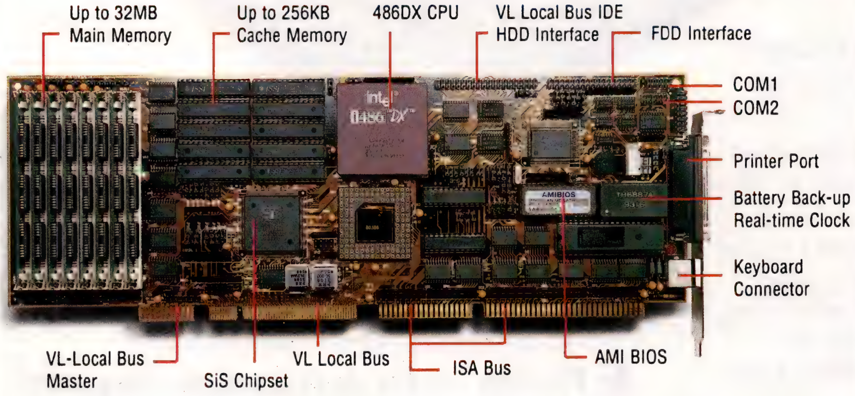
☎ (415)322-5322 FAX: (415)322-0455
115 Constitution Dr., Menlo Park, California 94025 USA

BASICS OF SCSI BOOK AVAILABLE FREE!

ANCOT CORPORATION

CIRCLE 188 FOR U.S. RESPONSE
CIRCLE 189 FOR RESPONSE OUTSIDE THE U.S.

VL-BUS 486DX INDUSTRIAL SINGLE-BOARD COMPUTER



IPC-M3033 486DX VL-BUS AIO CPU CARD

Features:

- 80486DX/SX, DX2 and AMI BIOS
- 256 KB 2nd-level Cache Memory
- Up to 32MB of On-board DRAM
- Supports 3-slot VESA Bus Master
- Built-in: VL-Bus IDE HDD Interface
  FDD Interface 2 Serial Port / Printer Port
- On-board Keyboard Connector
- Battery Back-up Real-time Clock/Calendar
- 8-layer PCB Contraction/0-60°C

CeBIT'94
HANNOVER
16~23.03.1994
HALL/020 Stand No. C39/1

MACROTEK
International Corp.
1F, No.53, Lane 228 Sec.5 Nanking E. Rd.
Taipei, Taiwan, R.O.C.
Tel: 886-2-7535328~9, 7568260~2
Fax: 886-2-7607436, 7532486

CIRCLE 277 FOR U.S. RESPONSE
CIRCLE 278 FOR RESPONSE OUTSIDE THE U.S.

ELECTRONIC DESIGN

Editor-in-Chief: Stephen E. Scrupski

Executive Editor: Roger Allan

Managing Editor: Bob Milne

Senior Editors: Frank Goodenough,
Milt Leonard, John Novellino

Technology Editors:
Advanced Technology: Jack Shandle
Analog & Power: Frank Goodenough
Communications & Industrial:
Milt Leonard (San Jose)
Components & Packaging: David Maliniak
Computer-Aided Engineering:
Lisa Maliniak
Computer Systems: Richard Nass
Semiconductors: Dave Bursky (San Jose)
Software: Sherrie Van Tyle
Test & Measurement: John Novellino
London: Peter Fletcher
To contact, call or write:
611 Route 46 West
Hasbrouck Heights, NJ 07604
(201) 393-6262 or (201) 393-6270
Fax (201) 393-0204

News Editor: Clifford Meth

Field Correspondents:
West Coast Executive Editor:
Dave Bursky (San Jose)
Communications & Industrial:
Milt Leonard (San Jose)
To contact, call or write:
2025 Gateway Plaza, Suite 354
San Jose, CA 95110
(408) 441-0550

Chief Copy Editor: Roger Engelke Jr.

Contributing Editors:
Ron Kmetovicz, Robert A. Pease

Editorial Production Manager:
Pat A. Boselli
Production Coordinator: Wayne M. Morris

Group Art Director: Peter K. Jeziorski

Associate Art Director: Tony Vitolo

Staff Artists: Tom Pennella, Linda Gravell

Editorial Support Supervisor:
Mary James

Editorial Assistant: Ann Kunzweiler

Editorial Assistant: Bradie Nieto

Vice President-Editorial: Perry Pascarella

Advertising Production:
(201) 393-6093 or Fax (201) 393-0410

Production Manager: Mike McCabe
Assistant Production Manager:
Eileen Slavinsky
Production Assistants:
Lucrezia Hlavaty, Joyce Borer

Circulation Manager: Susan Brown

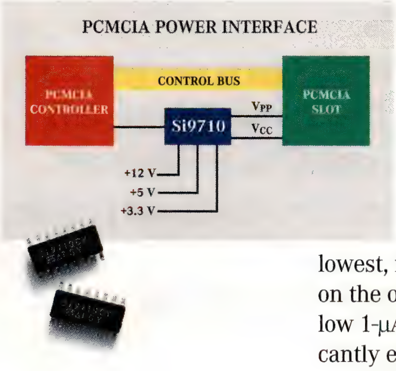
Reprints: Anne Adams
Penton Reprints 1-800-659-1710

Published by Penton Publishing

Publisher: John R. Carroll

Nothing stacks up like our new interface chip.

Now computer designers can downsize and simplify PCMCIA power management in all application types.


PCMCIA POWER INTERFACE

A smaller PCMCIA interface.

Our highly integrated monolithic Si9710CY interface switch eliminates many external components – reducing system size and improving reliability.

A more efficient PCMCIA solution.

This PCMCIA rev. 2.1 compatible IC has on-resistance as low as 150 mΩ, the industry's lowest, for improved tolerance on the output voltages. And its low 1-µA leakage current significantly extends battery life.

A simpler Plug and Play design.

The Si9710CY, by eliminating up to seven power discretes and drivers, simplifies the design task and reduces design cycle time.

Get more efficient host adapter designs.

Contact your local Siliconix/ TEMIC sales office. Or call our toll-free hot line and ask for more technical information. **1-800-554-5565, ext. 515.**

Siliconix
A Member of the TEMIC Group

2201 Laurelwood Road, Santa Clara, CA 95054
Fax: 408-970-3995, Attn. 515

Members of TEMIC Semiconductors: Telefunken Semiconductors, Siliconix, Matra MHS, Dialog Semiconductor
TEMIC International Sales: UNITED KINGDOM: 0344-485757. GERMANY: 07131 67-0. FRANCE: 1-30 60 70 00. ITALY: 02-332 121.
SCANDINAVIA: 08-733-0090. SINGAPORE: 65-788-6668, ext. 249. HONG KONG: 852-3789789. JAPAN: 3-5562-3321.

"If you doubt the power of advertising I suggest you consult a doctor."

"Colon cancer is a disease that afflicts more than 150,000 Americans each year and eventually kills over half. Yet, any doctor will tell you that with early detection, the survival rate could be raised to as much as 90%.

Can advertising have the power to make people confront this disease, overcome their fear and actually consult their doctors about it?

You bet your life it can.

Take the case of the Advertising Council's campaign against colon cancer. The first-ever study of public service advertising that actually isolated the impact of advertising from other market elements like the news, editorials and public relations.

Research was conducted from July 1989 to July 1990 in 4 markets in 10,000 households, at the equivalent of $21.3 million worth of air time, the average amount of donated time behind Advertising Council spots.

After six months of being exposed to one commercial, awareness of colon cancer among adults 40 and over rose from 11% to 29%.

After a year, awareness reached 40%.

The number of men who consulted their doctors more than doubled to 15%.

Now, if advertising can get people to see their doctors about something as unpalatable as colon cancer, don't you think it can get people to consider your product?

Don't find out colon cancer is curable too late in life.

Herb Baum, Pres., Campbell North & South America and Chm. of the Advertising Council.

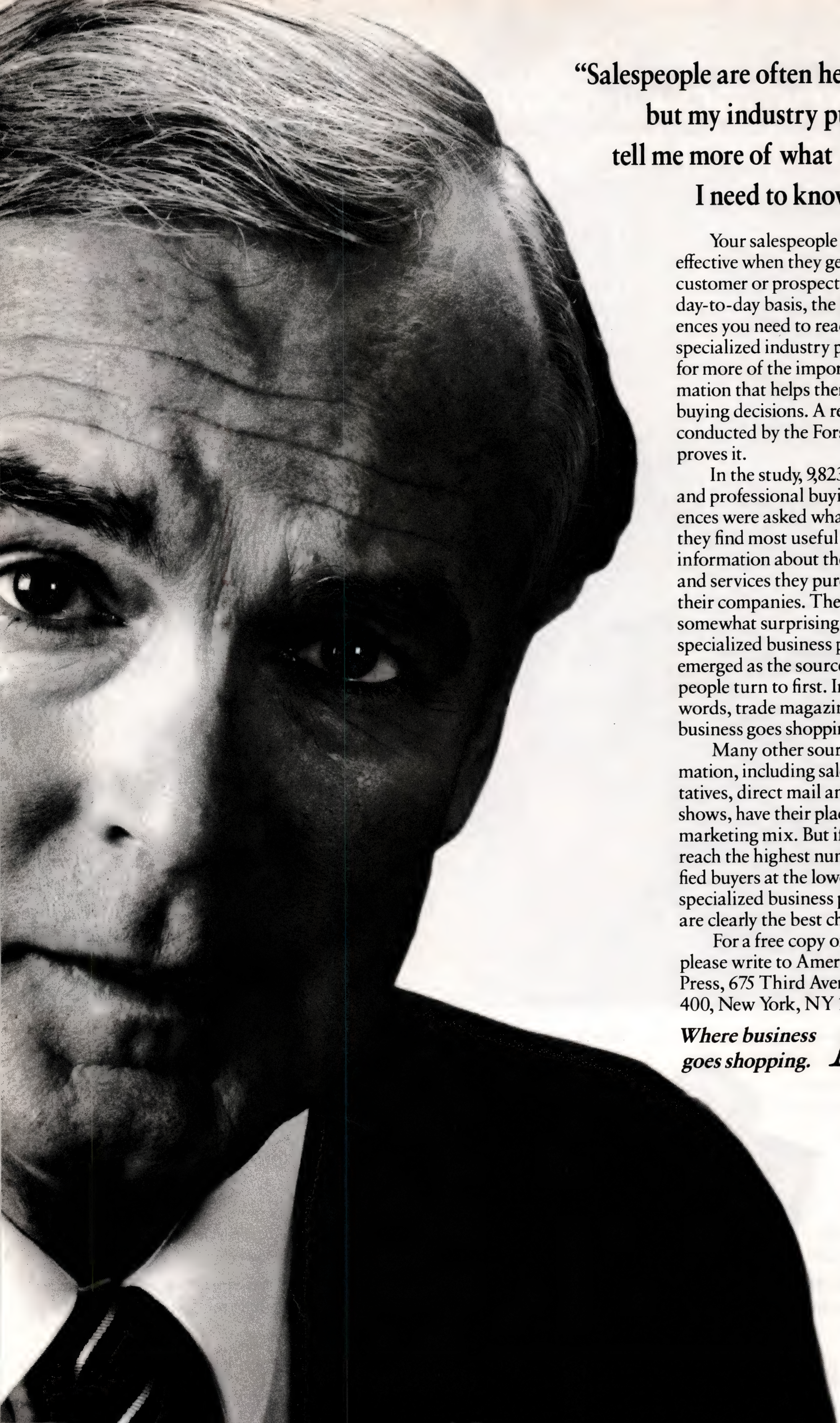
Oh, there's one more thing. If you're over 40, ask your doctor about colon cancer."

AAAA

American Association of Advertising Agencies

If you would like to learn more about the power of advertising, please write to Department D, AAAA, 666 Third Avenue, New York, New York 10017, enclosing a check for five dollars. You will receive our booklet *It Works! How Investment Spending In Advertising Pays Off.* Please allow 4 to 6 weeks for delivery.

This advertisement was prepared by Calet, Hirsch & Ferrell, Inc., New York, New York: Photo: Fred Weber.



“Salespeople are often helpful, but my industry publications tell me more of what I need to know.”

Your salespeople can be effective when they get to see a customer or prospect. But, on a day-to-day basis, the buying influences you need to reach turn to specialized industry publications for more of the important information that helps them make buying decisions. A recent study, conducted by the Forsyth Group, proves it.

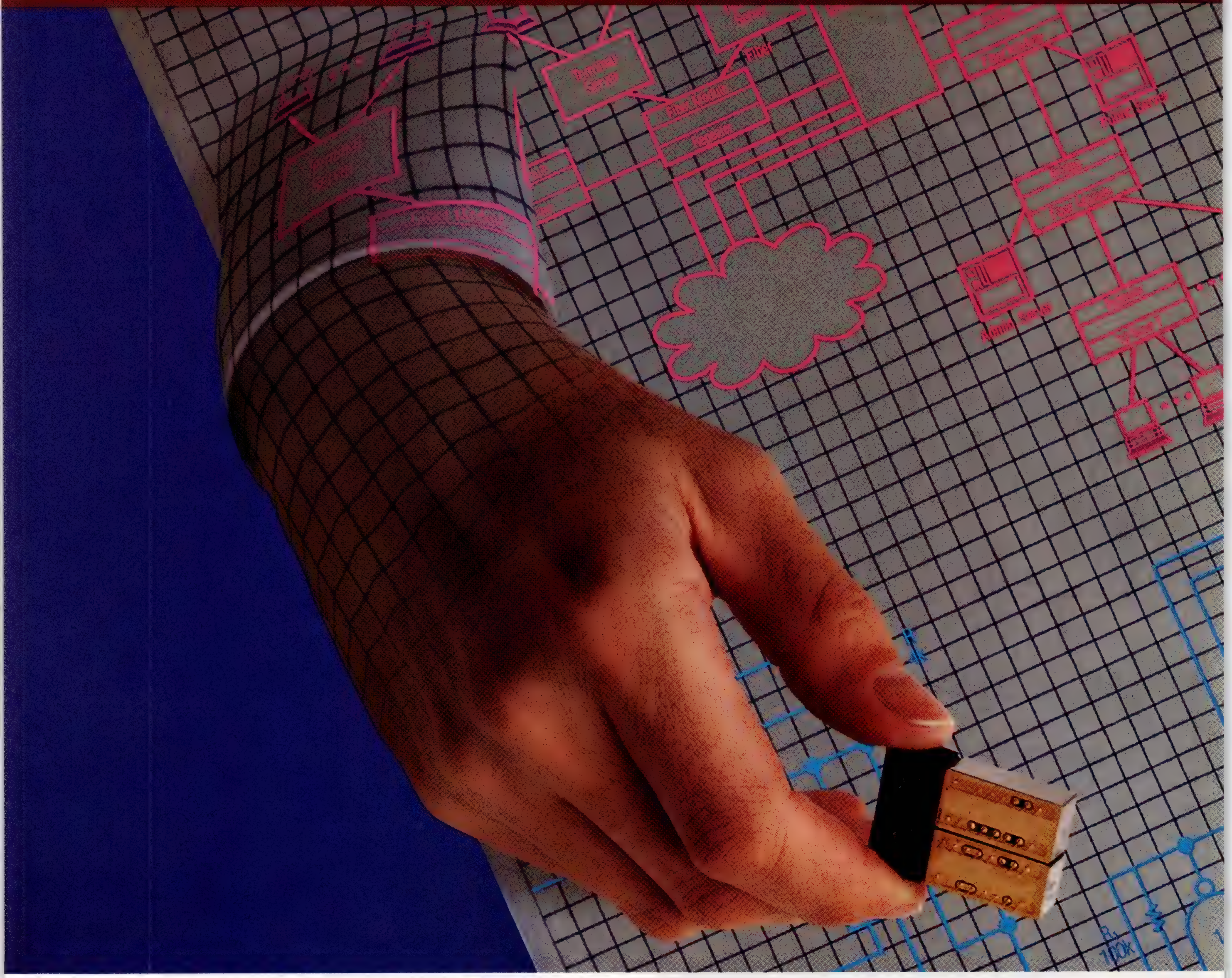
In the study, 9,823 business and professional buying influences were asked what sources they find most useful in providing information about the products and services they purchase for their companies. The results were somewhat surprising. Overall, specialized business publications emerged as the source business people turn to first. In other words, trade magazines are where business goes shopping.

Many other sources of information, including sales representatives, direct mail and trade shows, have their place in the total marketing mix. But if you want to reach the highest number of qualified buyers at the lowest cost, specialized business publications are clearly the best choice.

For a free copy of the study, please write to American Business Press, 675 Third Avenue, Suite 400, New York, NY 10017.

Where business goes shopping. ABP

Where product and network designers turn for a helping hand in fiber optics.



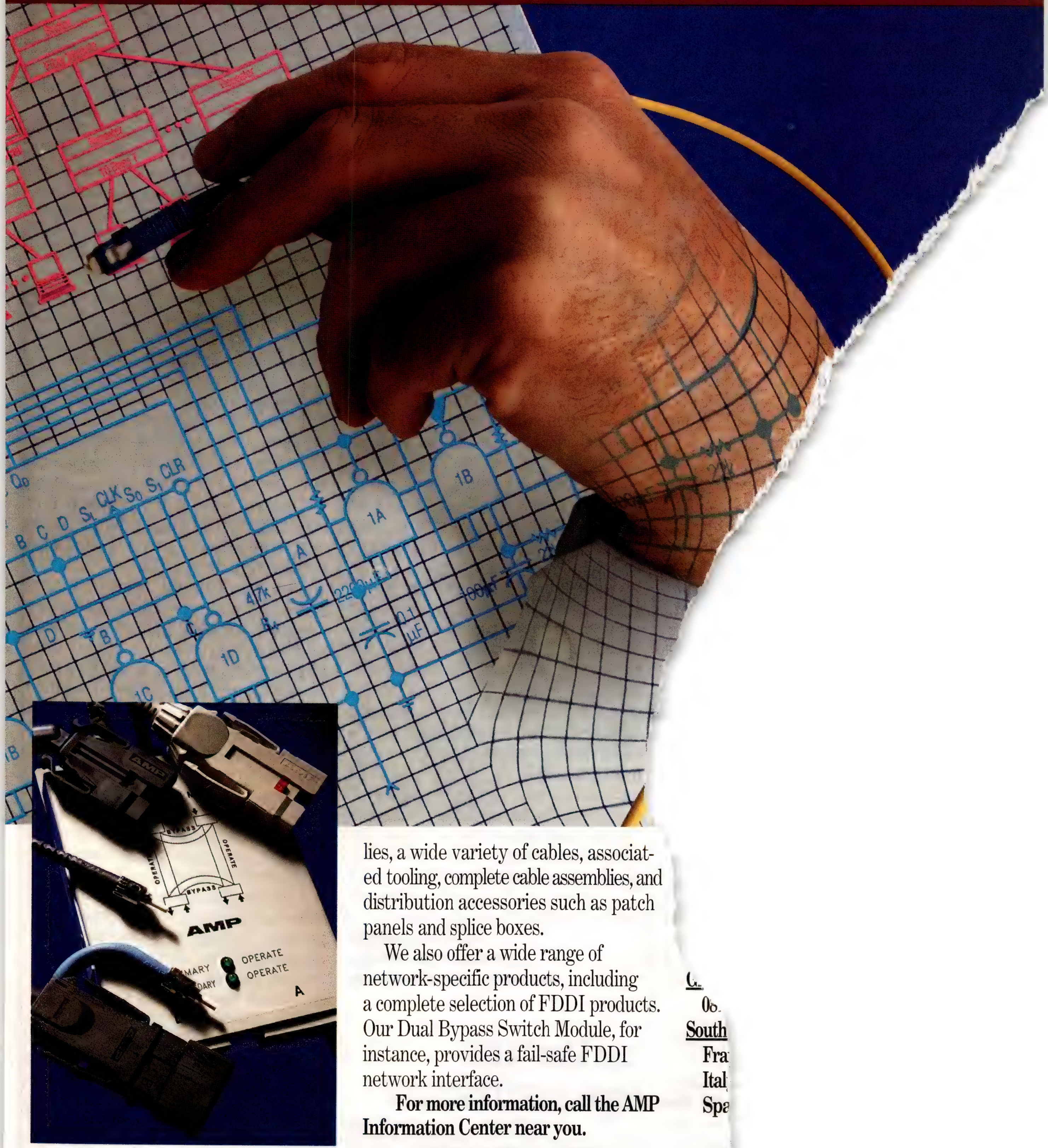
Product design and network implementation sometimes seem to lie on opposite ends of the fiber spectrum; practitioners of each can spend an entire career without meeting.

Where do they find common ground? For AMP customers, the answer is simple: one supplier. One supplier who understands both sides of the fiber equation. Who has pursued fiber technology from its beginnings. Who has played and continues to play a major role in key standards organizations. Who ultimately provides a bridge of technology and support between the hardware side and the transport side of today's fiber networks.

AMP LEDs, laser diodes, and detectors are an easy way to make the transition from pcb, panel, or bulkhead to cable. Our data links contain everything you need for a logic-to-logic interface, and come with today's popular FDDI, ST, SC, and other connectors built in. They're about as close as you can get to a plug-and-play fiber link.

Our general fiber and network products include multiple connector fami-

AMP is a trademark of AMP Incorporated.
ST is a trademark of AT&T.



lies, a wide variety of cables, associated tooling, complete cable assemblies, and distribution accessories such as patch panels and splice boxes.

We also offer a wide range of network-specific products, including a complete selection of FDDI products. Our Dual Bypass Switch Module, for instance, provides a fail-safe FDDI network interface.

For more information, call the AMP Information Center near you.

CIRCLE 84 FOR U.S. RESPONSE

08

South

Fra

Ital

Spa

CIRC

THIS IS AMP TODAY.

ACRONYM INVENTORS: CONSULT REFERENCES

I always enjoy reading your "40 Years Ago" page and your regular editorial. However, the editorial on acronyms (September 16) hit home in several ways. First, I collected acronyms for years because I couldn't remember what the new ones meant. Second, I also found that there were many duplicate
cronyms with different meanings;
example: ACS (9 entries); DMS (9
ies); PC (9 entries, plus one lower
); EMS (8 entries); etc.
also intrigued to find 228
ords used as acronyms.
om my book, Acronyms
ations of Computer
d Telecommunica-
by Marcel Dekker,
ins some 7000
nited in scope at
ose we could
inventors to
reference
cronym?
ll that
! I'm
what
its

n
n
st
ll
s,
ed
with

ber of
growing
rance of
reasing.
ith the
be very
cles that
ns. The
l that at
least one journal prints a list of definitions following each article. I also collect file extensions.

I would be interested to hear how many others wrote to say that they, too, were collecting acronyms.

SEWARD J. BAKER, M.D.
PONTE VERDRA BEACH, FLA.

LISTEN TO YOUR COMPUTER

Your "40 Years Ago" article, in the December 2, 1993 issue, about the SWAC computer had a mention
of the loud-speaker that allowed one
to listen to the system operatin
You asked if anyone listened to th
computers nowadays. Well yes
do. I know of engineers who
standard medium wave amp
modulated radio to fault f
equipment. They simply liste
noise signature. They car
missing components or i
components of the signat
from experience, head in
direction to the fault.

I myself used this method s
years ago on a desk calculator
used Nixie tubes for display a
boards of two transistor flip
for logic. A 64 by 4 ferrite stor
the main memory. Normally, I
identify the fault down to a spe
logic area from a quick listen to
radio. Many customers doubted th
method at first. Sadly modern machines that I design are too fast for detailed noise signature analysis. Visual methods using a 'scope are necessary today. (Not that my designs ever need servicing!!!! Like ED, they are almost perfect—perfection produces complacency).

BERNARD GREEN
UNILEVER RESEARCH
BEDFORD, UNITED KINGDOM

AEA SAYS "LET'S SOLVE SOME PROBLEMS"

The American Engineering Association (AEA) is dedicated to the enhancement of the engineering profession and to engineering
excellence in American
Therefore, I believe it i
for me to comment o
"More Musings On
On the subjec
outlook for eng
Lewis has rev
losses due
Procurem
1997. T
engineer
scienti
losse
cat
m

IEEE has testified and supported engineering job cuts while requesting increased funding to NSF for degree production. Who will ask Congress to cut funding for these colleges and NSF?

You also mention the antagonism between engineers and the members of the academic community. It

Scandinavia:
Sweden 0758-104 00 (fax 0758-194 70);
Central Europe:
Holland 073-200 911 (fax 073-212 365),
Germany 06103-709 659 (fax 06103-709 619);
reat Britain:
1-954 2356 (fax 081-954 6234);
ern Europe:
nce 1-34 43 27 20 (fax 1-3030 4550),
y 011-71731 (fax 011-773 1116),
in 03-200 84 66 (fax 03-201 78 79).

LE 85 FOR RESPONSE OUTSIDE THE U.S.

AMP

exists. Less than 10 percent of IEEE's members are academics, yet they hold more than 60 percent of the seats on the Board of Directors. The fight of engineer activists against the influence of academics in IEEE to support the engineers and admit that we have an engineering manpower surplus in the U.S. has been a lost fight. The academics get paid by the colleges to participate in the engineering societies to protect their interests. We fight in committees just to get our concerns on the agenda, and we lose.

Engineering Shortage Propaganda and college marketeering get our youth interested in pursuing the engineering curriculum and fills the pipeline to the engineering colleges. Maintaining degree production is a primary goal of the typical, academic-managed, engineering societies and the National Science Foundation. Only AEA is willing and able to battle these foes.

But we all know about these issues; what are we going to do about them? You say "solving problems is what motivates most engineers in the first place." So, let's solve some problems.

We have the American Engineering Association, which includes members from all engineering disciplines and industries. This gives us a potential membership of about two million engineers, or almost ten times the size of IEEE. AEA will be the largest engineering association in the U.S., organized and run by engineers. We are here to solve our problems.

AEA is academic-free; our goal is to support the needs of the engineering community, seek an engineering manpower balance, and oppose Engineer Shortage Propaganda. We can respond quickly on political issues and we reach engineers from all disciplines in all industries. Our publication, "American Engineer," addresses our professional concerns and keeps our members informed. AEA has the respect of members of Congress and they speak with us directly. Our annual fee is less than one-third of IEEE's, and we are working for engineers, not against their interest.

Of course, AEA is not without its own problems. A lack of funding has limited our activities. We seek the support of the engineering community. We need funds to advertise for members and we need membership funding to cover the cost of advertising. Only 50,000 members will assure our success and make things happen in Washington. This is less than 3 percent of the U.S. engineering population. A good benefit and insurance package will come with increased membership, and assure additional growth.

We can provide opportunities for engineers, but we do need all the help we can get to increase our membership to fighting strength.

RICHARD F. TAX
VICE PRESIDENT
AMERICAN ENGINEERING ASSOCIATION
FT. WORTH, TEXAS

TINKERTOY AND MICKEY MOUSE

The article on "Project Tinkertoy" in the Oct. 1 issue reminded me of a similar project at RCA, Somerville, N.J., in 1959. Transistors were used instead of tubes, though. New employees were shown a publicity film which explained the construction technique, nearly identical to the ceramic wafers or layers used in the Tinkertoy project, interconnected by vertical wires. If memory serves me correctly, one module was a helmet-mounted radio receiver. The film touted the benefits of standardized, modular, automated, miniature construction, and at the end of the film, 1-in. cubical modules were optimistically depicted pouring onto a conveyor belt. It was called the Micro Module project, and certain wags felt that the MM initials were those of a well-known Disney character.

It was a good idea at the time, and I'm sure it's stating the obvious to say that the benefits of the MM project were achieved a few years later with ICs. Perhaps ICs were anticipated, because I also recall hearing about research into "molecular" electronics. Whatever happened to that?

MARVIN T. ANDERL
RICHMOND, VA.

GIBSON GIRL RADIO: KITES STILL AVAILABLE

I always enjoy reading *Electronic Design*, usually beginning with Ideas for Design, Pease Porridge, and 40 Years Ago. (I know about the CK722—it was the first transistor I worked with, and the circuit worked the first time.)

I was especially interested in the Readers Comments column in the Nov. 1 issue about the "Gibson Girl" lifeboat radio, particularly the kite. Your readers pointed out that the radio was still available. Well so is the kite.

Last summer, our company built and delivered a quantity of these same kites to the military. They are box kites that can raise several hundred feet of fine wire for a radio antenna. (We make more complex antennas and other communications devices for the military). As reader David Zimmerman pointed out, it is a terrific flier. Naturally, as VP of Engineering, and with our VP of Manufacturing, we had to test out our product, and gave it a "field test" on our front lawn. We easily got it up using 30 lb. fish line, and had let out a good 300 to 400 ft. of line before Engineering and Manufacturing gave it our stamp of approval. It was a much different test than we usually do in our test programs.

Many people take kite flying very seriously and pay hundreds of dollars for special stunt kites, but lucky is the kite enthusiast who has one of these, because it does fly high. I suppose if they were in enough demand, our company would consider producing a run for kite and military surplus buffs. Amateur radio operators could use them on "field day," too.

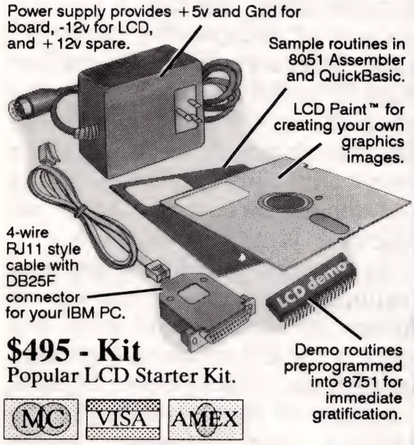
JOHN E. KEIM
V.P. ENGINEERING
CIRCLE PRIME MFG. CO.
CUYAHOGA FALLS, OHIO

LCD Proto Kit

Everything you need to start your LCD application .... create complex screens in just a few hours!

240 x 64 pixel Supertwist LCD mounts directly onto CYB003 proto-typing board.
Kit provides serial interface to IBM PC for quick prototyping. Board also supports displays up to 240 x 128 pixels.
Interface to 6 soft keys or 4 x 4 key matrix.
Dial 0-25k ohms for LCD contrast.
CY325 LCD CONTROLLER
* The CY325 LCD Windows Controller provides parallel or serial high-level control of Instrument-size LCDs. Up to 256 built-in windows support window-relative text, bargraphs, waveforms, and plots. Text and graphics are maintained in separate planes, facilitating special effects. Complete User Manual included.
Wirewrap area for custom circuitry or back-light.
RJ 11 serial jack for RxD, TxD, CTS, and GND, plus 2 spares.
5 Pin Power DIN.
Alternate Power Connector.
Add your own 8051 CPU for stand alone operation.

Kit also includes:


Power supply provides +5v and Gnd for board, -12v for LCD, and +12v spare.
Sample routines in 8051 Assembler and QuickBasic.
LCD Paint™ for creating your own graphics images.
4-wire RJ11 style cable with DB25F connector for your IBM PC.
LCD demo
Demo routines preprogrammed into 8751 for immediate gratification.

$495 - Kit
Popular LCD Starter Kit.

MC VISA AMEX

($595 pre-assembled & tested)

***The CY325 CMOS 40-pin DIP and 44-pin PLCC LCD Controller IC are available from stock @ $75/singles, $20/1000s .**

CyberneticMicroSystems
Box 3000 • San Gregorio CA 94074
Tel: 415-726-3000 • Fax: 415-726-3003

CIRCLE 281 FOR U.S. RESPONSE
CIRCLE 282 FOR RESPONSE OUTSIDE THE U.S.

A BRIGHTER FORECAST FOR '94

Happy New Year to our readers around the world. All the members of *Electronic Design's* editorial staff extend their best wishes for a healthy, prosperous, and professionally satisfying 1994. This seems to be the appropriate time to look ahead to what the next 12 months have in store, especially since it appears the year is ringing in on an upbeat note.

It could very well turn out to be a watershed year for the electronics industry as many new technologies turn into useful products. Pen-based computers, multimedia systems, wireless data communications—all seem ready for widespread use, particularly in a growing economy. The U.S. economy seems to be rebounding and most analysts are predicting a strong year ahead. Consumer spending during the holiday season showed strength and rising credit-buying indicates strengthening consumer confidence. And, because consumer spending significantly impacts the spending by manufacturers and business firms on productivity-improving capital equipment, it could turn out to be the best year the electronics industry has enjoyed in a long time.

Technology innovations for coming year look strong—*Electronic Design's* editors are already receiving early word from developers regarding new devices and equipment that could appear as products this year. The International Solid-State Circuits Conference (Feb. 16-18, San Francisco) program, for example, is packed with new developments. In this issue (p. 36), we offer a brief preview of some of the more interesting advances. In our Feb. 21 issue, we will present our traditional 20-plus pages of in-depth ISSCC analysis.

For *Electronic Design* itself, 1994 will be an exciting year. Once again, we will publish a full slate of Special Reports, Conference previews, and Design Applications articles, as well as our usual regular features of Pease Porridge, Ideas for Design, QuickLook, and the rest. We also will publish five Engineering Software special supplements during the year. These supplements will be aimed primarily at the growing number of engineers who are specializing in embedded software development. The first Engineering Software supplement, which will appear as a section of the Feb. 21 issue of *Electronic Design,* will contain articles discussing such topics as writing and debugging embedded software, the use of C++ language, and the impact of software standards. For the supplement, we also plan to develop a software equivalent of our ever-popular Ideas for Design section. This issue's Ideas for Design section (p. 117) explains what we're looking for and how to submit the articles.

All in all, 1994 promises to be an interesting year—for the electronics industry, for *Electronic Design* magazine, and for our readers.

Steve Scrupski

Editor-in-Chief

DC-2000 MHz

AMPLIFIERS

In plastic and ceramic packages, for low-cost solutions to dozens of application requirements, select Mini-Circuits' flatpack or surface-mount wideband monolithic amplifiers. For example, cascade three MAR-2 monolithic amplifiers and end up with a 25dB gain, 0.3 to 2000MHz amplifier for less than $4.50. Design values and circuit board layout available on request.

It's just as easy to create an amplifier that meets other specific needs, whether it be low noise, high gain, or medium power. Select from Mini-Circuits' wide assortment of models (see Chart), sketch a simple interconnect layout, and the design is done. Each model is characterized with S parameter data included in our 740-page RF/IF Designers' Handbook.

All Mini-Circuits' amplifiers feature tight unit-to-unit repeatability, high reliability, a one-year guarantee, tape and reel packaging, off-the-shelf availability, with prices starting at 99 cents.

Mini-Circuits' monolithic amplifiers...for innovative do-it-yourself problem solvers.

Models above shown actual size

from **99¢** Unit price $ (25 qty)

PLASTIC SURFACE-MOUNT			++VAM-3 1.45		+VAM-6 1.29	++VAM-7 1.75		
add suffix SM to model no. (ex. MAR-ISM)	MAR-1 1.04	MAR-2 1.40	MAR-3 1.50	MAR-4 1.60	MAR-6 1.34	MAR-7 1.80	MAR-8 1.75	
	MAV-1 1.15	+MAV-2 1.45	+MAV-3 1.55	MAV-4 1.65				MAV-11 2.15
CERAMIC SURFACE-MOUNT	RAM-1 4.95	RAM-2 4.95	RAM-3 4.95	RAM-4 4.95	RAM-6 4.95	RAM-7 4.95	RAM-8 4.95	
PLASTIC FLAT-PACK	MAV-1 1.10	+MAV-2 1.40	+MAV-3 1.50	+MAV-4 1.60				MAV-11 2.10
	MAR-1 0.99	MAR-2 1.35	MAR-3 1.45	MAR-4 1.55	MAR-6 1.29	MAR-7 1.75	MAR-8 1.70	
Freq.MHz,DC to	1000	2000	2000	1000	2000	2000	1000	1000
Gain, dB at 100MHz	18.5	12.5	12.5	8.3	20	13.5	32.5	12.7
Output Pwr. +dBm	1.5	4.5	10.0	12.5	2.0	5.5	12.5	17.5
NF, dB	5.5	6.5	6.0	6.5	3.0	5.0	3.3	3.6

Notes: + Frequency range DC-1500MHz ++ Gain 1/2 dB less than shown

designer's amplifier kits

DAK-2: 5 of each MAR-model (35 pcs), only $59.95
DAK-2SM: 5 of each MAR-SM model (35 pcs) only $61.95
DAK-3: 3 of each MAR, MAR-SM, MAV-11, MAV-11SM (48 pcs) $74.95

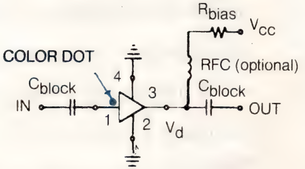
designer's chip capacitor kit

KCAP-1: 50 of 17 values, 10pf to 0.1μf (850 pc), $99.95

chip coupling capacitors at .12¢ each (50 min.)

Size (mils)	Value
80 x 50	10, 22, 47, 68, 100, 220, 470, 680 pf
80 x 50	1000, 2200, 4700, 6800, 10,000 pf
120 x 60	.022, .047, .068, .1μf

Typical Circuit Arrangement



finding new ways ...
setting higher standards

Mini-Circuits™

WE ACCEPT AMERICAN EXPRESS AND VISA

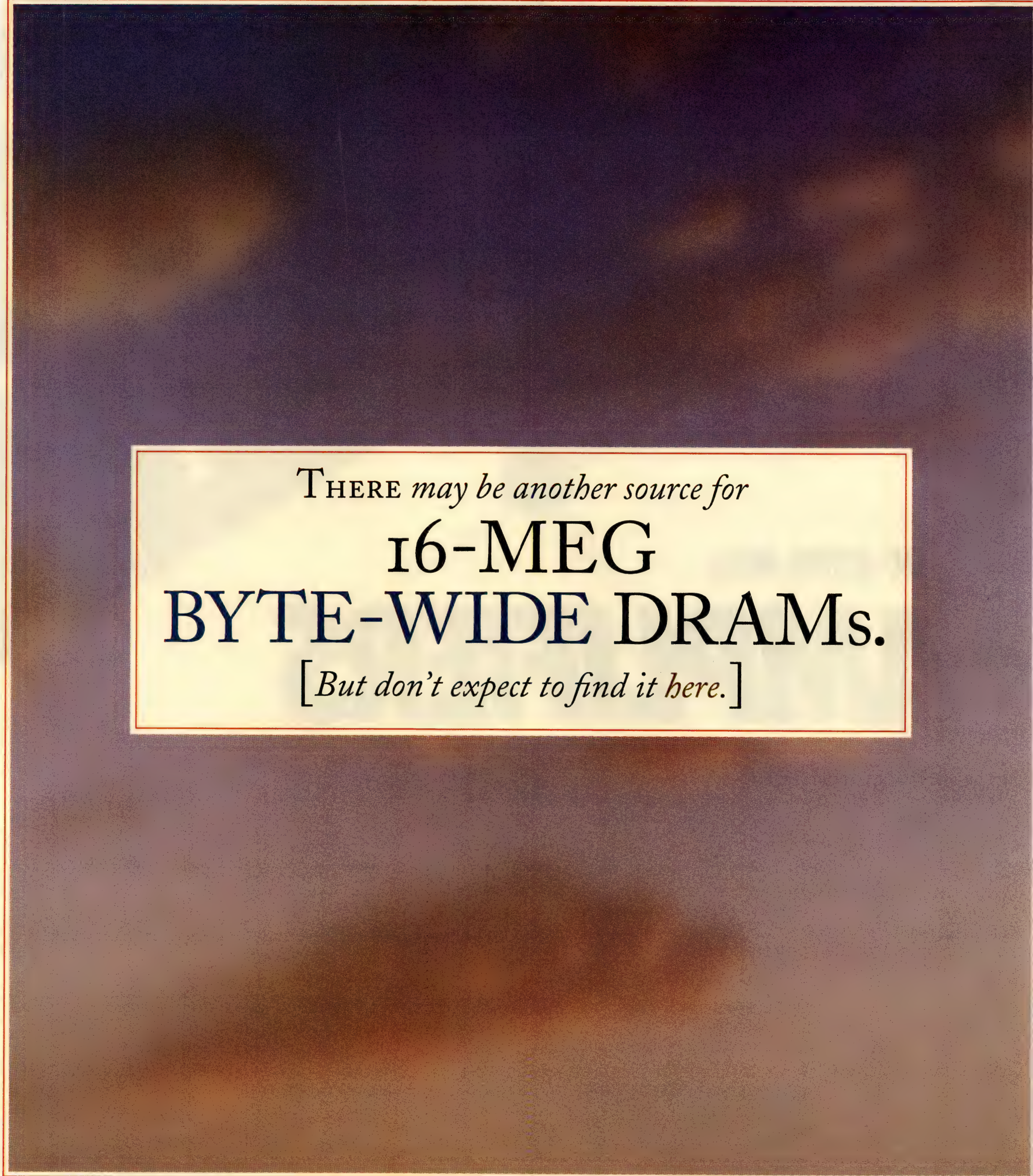
P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661

Distribution Centers / NORTH AMERICA 800-654-7949 • 417-335-5935 Fax 417-335-5945 EUROPE 44-252-835094 Fax 44-252-837010

For detailed specs on all Mini-Circuits products refer to • THOMAS REGISTER Vol. 23 • MICROWAVES PRODUCT DIRECTORY • EEM • MINI-CIRCUITS' 740-pg HANDBOOK.

F154 REV. A

CIRCLE 283 FOR U.S. RESPONSE CIRCLE 284 FOR RESPONSE OUTSIDE THE U.S.



THERE *may be another source for*

16-MEG

BYTE-WIDE DRAMs.

[*But don't expect to find it here.*]

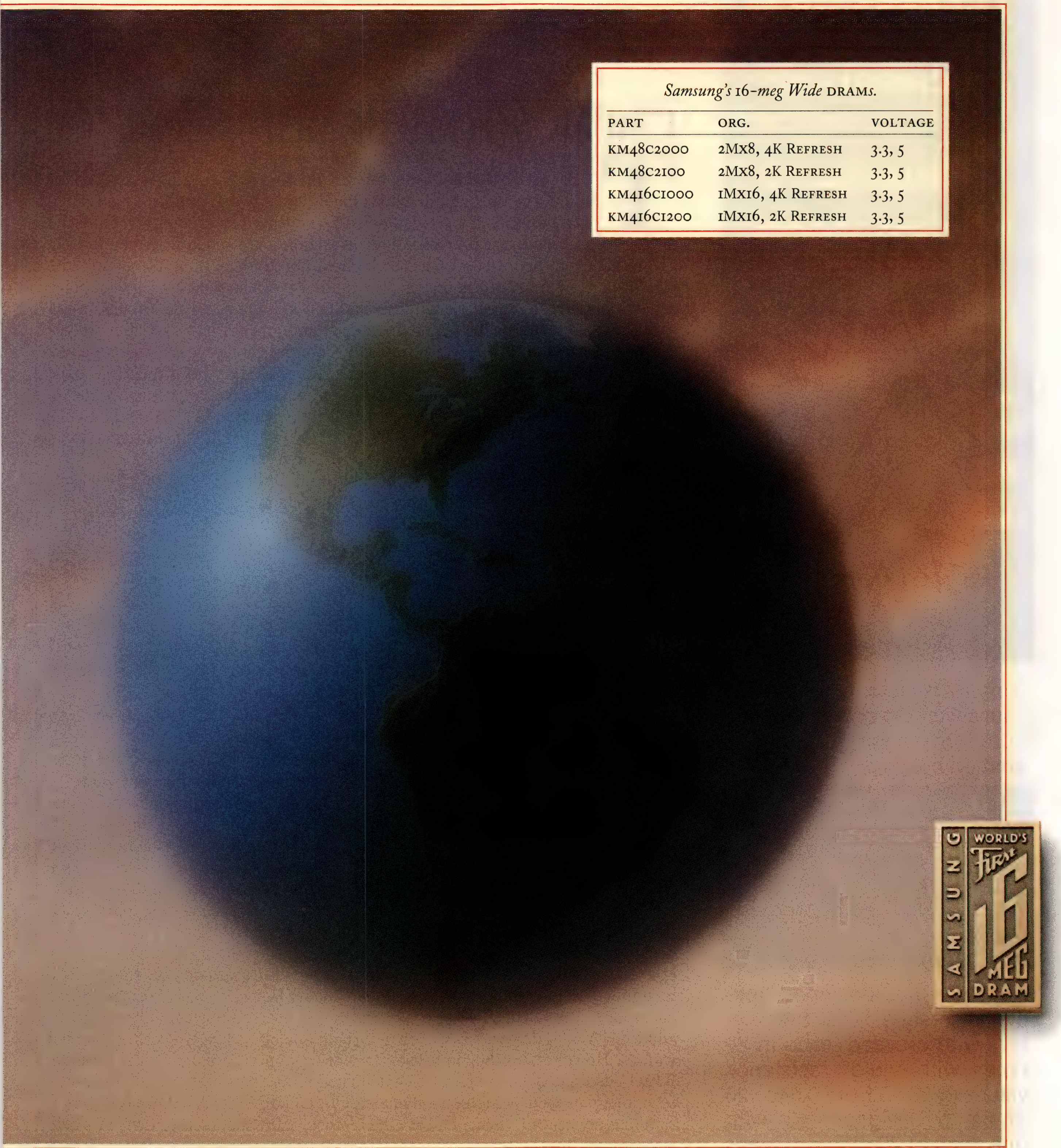
The ideal memory chip for any notebook computer or Personal Digital Assistant is a 16-meg wide DRAM.

Fortunately, there's a supplier that has them available right now. Right here on earth. But only one. Samsung.

Our two word-wide and two byte-wide DRAMS let you create a dense memory with just a few chips. Which is exactly what small computers need. And since we make them in both 5 and 3.3 volt, you can also give your customers the low-power, long-running products they've been craving.

Beyond that, as you evolve further generations of the palmtop and PDA, and transform the computer into the kind of remarkable does-it-all assistant that used to seem

© SAMSUNG SEMICONDUCTOR, INC., 1993.



Samsung's 16-meg Wide DRAMS.

PART	ORG.	VOLTAGE
KM48C2000	2MX8, 4K REFRESH	3.3, 5
KM48C2100	2MX8, 2K REFRESH	3.3, 5
KM416C1000	1MX16, 4K REFRESH	3.3, 5
KM416C1200	1MX16, 2K REFRESH	3.3, 5

like science fiction, you'll have memory chips equal to the task.

At Samsung, we were the first to complete the 16-meg DRAM. We've built on our lead in memory with a revolutionary synchronous DRAM, with low-voltage products, and with what is probably the broadest line of SRAMS—yes, on earth. And today in the byte-wide, we're bringing you the most advanced 16-meg product available.

For more information on Samsung's enabling DRAMS, please call 1-800-446-2760 or 408-954-7229. Or write to DRAM Marketing, Samsung Semiconductor Inc., 3655 N. First St., San Jose, CA 95134.

SAMSUNG

A *Generation* AHEAD.

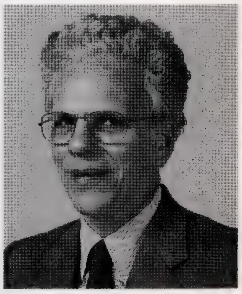
CIRCLE 267 FOR U.S. RESPONSE CIRCLE 268 FOR RESPONSE OUTSIDE THE U.S.

CBiCMOS TUNES UP MIXED-SIGNAL ICs

The performance squeezed from complementary-bipolar CMOS (CBiCMOS) technology is quickly making it the ultimate process for building complex high-speed mixed-signal ICs. It offers a broad range of capabilities for active devices: Vertical npns and pnps handle the analog tasks needing dc precision, low distortion, high speed/wide bandwidth, and high output drive, as well as the highest-speed logic. In addition, fine-line CMOS handles most of the digital jobs (and also offers such analog capability as low-bias current circuits, switches, and non-voltage-sensitive capacitors).

Many analog semiconductor suppliers, large and small, already have the process in place, while others are gearing up quickly. Over the last few years, such suppliers as Analog Devices, EXAR, Harris, Hughes, Motorola, Raytheon, and VTC have developed CBiCMOS processes. All of these processes deliver impressive performance. For instance, their npns sport f_ts ranging between 3 and 11 GHz (VTC) while pnp f_ts fall between 0.8 and 4 GHz (VTC), and the CMOS FETs feature minimum effective gate lengths between 0.8 and 2 µm. Some of the CBiCMOS processes offer laser-trimmable thin-film resistors, and in one case, Motorola's process can build n-channel JFETs with an f_t of 2 GHz.

Although there's a broad manufacturing base for CBiCMOS ICs, not all suppliers followed the same route in developing their versions of the process, which exemplifies the engineers' creativity. Such techniques used by manufacturers included adding vertical bipolar transistors to an available CMOS process, incorporating a vertical pnp to a biCMOS process, or adding CMOS to a complementary bipolar process. Others designed their process from the ground up. And, while some have arrived only recently, second-generation versions are already in the works: Raytheon, for example, will unveil a second-generation process later this year, and Harris is planning a new version for next year.


FRANK GOODENOUGH
ANALOG & POWER

One big question circling around the high-speed/wideband analog IC arena is whether or not to move the almost mandatory complementary bipolar (CB) process, which is used by virtually all suppliers, from junction isolation (JI) to some form of dielectric isolation or SOI (silicon on insulator) technology *(see "SiGe, SOI To Lead Analog, Mixed Signal Processes," p. 85)*. Obviously, that move would also affect all current CBiCMOS processes, since they employ JI. But, the additional advantages in speed/bandwidth, versatility, and ease of design (due to the elimination of parasitics), and the potentially lower die cost offered by SOI, would seem to make a CBiCMOS process on SOI the obvious next move. For example, both Harris and Analog Devices have the technologies necessary: a JI CBiCMOS process and a CB process on bonded wafers. In addition, Analog Devices is working with an analog CMOS process on bonded wafers. However, neither is presently working on a CBiCMOS/SOI process. AT&T also has a head start in that direction as they have a bonded-wafer technology as well as high-speed analog CB, biCMOS, and CMOS processes.

While several of these JI CBiCMOS techniques use some form of oxide isolation within the transistors, the Hughes process comes the closest to SOI technology. Its isolation trenches stretch all the way to the substrate (ELECTRONIC DESIGN, *Nov. 22, p. 23)*. These deep trenches are similar to those used with bonded-wafer processes in which an oxide layer forms the substrate—the trench side walls are oxidized and then back-filled with polysilicon.

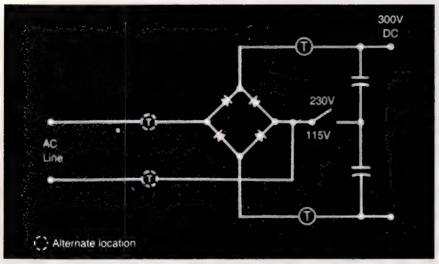
Finally, although CBiCMOS is an excellent process, don't look for many standard products based on it. Analog Devices, EXAR, and Harris have built data converters on their CBiCMOS processes, but the emphasis of those companies, as well as most others, has been on standard-cell libraries for custom or semicustom ICs. Only Hughes presently offers an array, while VTC uses its process, the fastest in the industry, in its own hard-disk drives.

LEADERSHIP IN THERMISTOR TECHNOLOGY

Keystone

INRUSH CURRENT LIMITERS

Turn to Keystone to protect your switching power supplies from turn-on surge . . . as diagramed below.



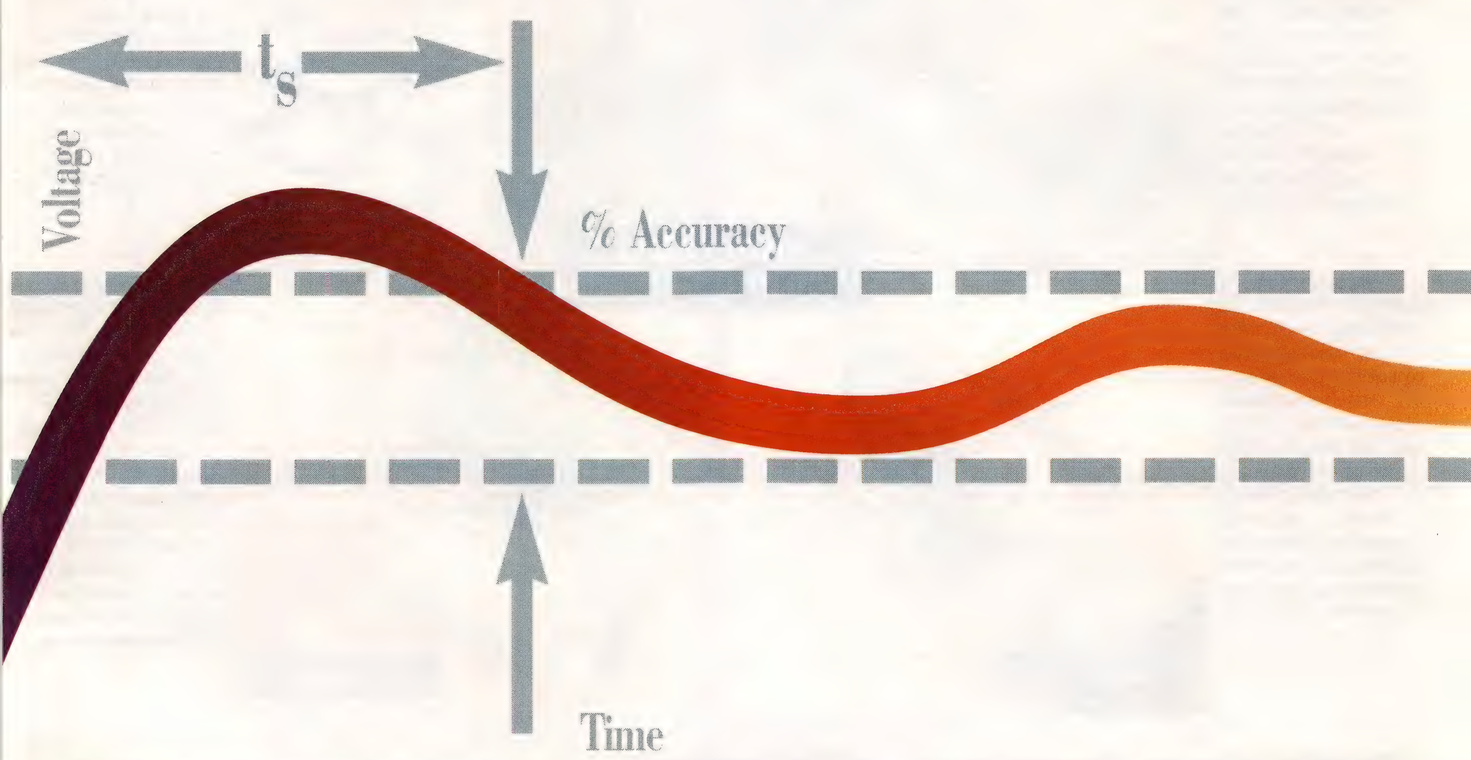
Keystone has designed special disc-style NTC thermistors with crossed leads in 20 types with "cold" resistance values @ 25° C from 0.5 to 120 ohms. A Designer's Kit with one each of 20 different types is available.

Keystone
CARBON COMPANY
Thermistor Division • St. Marys, PA 15857
814-781-1591 • FAX 814-781-7648
Keystone Thermistors are distributed by

Allied Electronics	1-800-433-5700
Dexter Corporation	1-800-345-4082
Digi-Key Corporation	1-800-344-4539
Newark Electronics	1-800-367-3573
Summit Distributors	1-800-678-6648

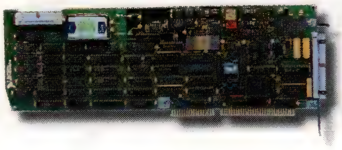
CIRCLE 120 FOR U.S. RESPONSE
CIRCLE 121 FOR RESPONSE OUTSIDE THE U.S.

This Settles It.



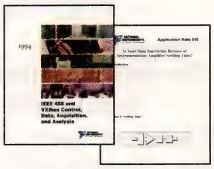
Avoid Inaccurate Data – Use DAQ Boards with the NI-PGIA™

You told us you wanted data acquisition (DAQ) boards that deliver full accuracy at any gain and at any multichannel sampling rate. So we developed the NI-PGIA – the custom instrumentation amplifier for our high-performance DAQ boards.



Using a DAQ board with the NI-PGIA – such as the AT-MIO-16F-5 – you can measure your signals without the settling time inaccuracies that commonly plague plug-in DAQ boards. Boards with the NI-PGIA can settle to 12 bits in 2 µs and to 16 bits in less than 40 µs, even when sampling multiple channels at high gains. That's more than five times faster than boards with the best off-the-shelf programmable gain instrumentation amplifiers!

Call for a FREE catalog, which has complete specifications on National Instruments DAQ products. Also, ask for our application note, "Is Your Data Inaccurate Due To Instrumentation Amplifier Settling Time?"



NATIONAL INSTRUMENTS®
The Software is the Instrument®

(800) 433-3488 (U.S. and Canada)

6504 Bridge Point Parkway • Austin, TX 78730-5039 • Tel: (512) 794-0100 • 95 (800) 010 0793 (Mexico) • Fax: (512) 794-8411

Branch Offices: Australia 03 879 9422 • Austria 0662 435986 • Belgium 02 757 00 20 • Canada 519 622 9310 • Denmark 45 76 26 00 • Finland 90 527 2321 • France 1 48 65 33 70 • Germany 089 714 50 93
Italy 02 48301892 • Japan 03 3788 1921 • Netherlands 03480 33466 • Norway 32 848400 • Spain 91 640 0085 • Sweden 08 730 49 70 • Switzerland 056 27 00 20 • U.K. 0635 523545

© Copyright 1994 National Instruments Corporation. All rights reserved. Product and company names listed are trademarks or trade names of their respective companies.

CIRCLE 138 FOR U.S. RESPONSE CIRCLE 139 FOR RESPONSE OUTSIDE THE U.S.

VersaPoint™ – Versatile Pointing Devices *For Virtually Any Application!*

VersaPoint cursor control modules replace clumsy mice, trackballs and touchscreens in harsh operating environments. The smooth, completely sealed construction is designed to meet NEMA 4X standards for reliable operation in wet, dirty or cleanser-prone environments. VersaPoint "drop-in" modules are ideal for integration into products such as industrial workstations, medical imaging systems and ruggedized computers.

VersaPoint technology offers cost effective joystick solutions in a wide variety of configurations. The Micro Joystick, featuring ultra-thin modular construction, is ideal for integration into palmtop and subnotebook computer keyboards. Larger ruggedized VersaPoint joysticks are durable enough for use in medical instruments and industrial computers. And all VersaPoint joysticks provide unique variable speed pointing control.

VersaPoint is the only pointing technology thin and light enough for integration into hand-held remote controllers. A patented zero-travel sensor delivers "one-touch" control of both speed and direction. And the low-power circuit design maximizes battery life. VersaPoint is the perfect integrated pointing solution for interactive TV, multimedia systems, toys, games, and machine motion control.

The VersaPoint MicroModule is the world's thinnest cursor controller – it can fit into tight spaces that were previously unusable! Requiring less than 1/4" mounting depth, the MicroModule is thin enough for portable or hand-held products. With no moving parts to gum up or wear out, it's the optimal pointing solution for notebook computers, test/measurement equipment, automotive diagnostic instruments and GPS navigational devices.

VersaPoint™ technology delivers "one-touch" control of both speed and direction. Just the touch of a fingertip delivers full 360° control of cursor speed and direction, simultaneously! Press in the direction you want the cursor to move – use light pressure for precise control, greater pressure for faster movement. VersaPoint solutions offer interfaces for either PS/2 mouse ports or standard serial ports, and are compatible with DOS, Windows™ and OS/2®. You can solve almost any pointing problem with VersaPoint cursor contol devices.

No moving parts to break or wear out. VersaPoint's patented Force Sensing technology replaces costly encoder and strain gage technologies. The patented zero-travel sensor eliminates the need for complicated and bulky mechanical assemblies. Cost effective solutions are easy with VersaPoint!

VersaPoint

Durable

Cost Effective

Turn-Key Solutions

Help . . .
(805)484-1331

INTERLINK
ELECTRONICS
546 Flynn Road
Camarillo, CA 93012
Fax: (805) 484-8989

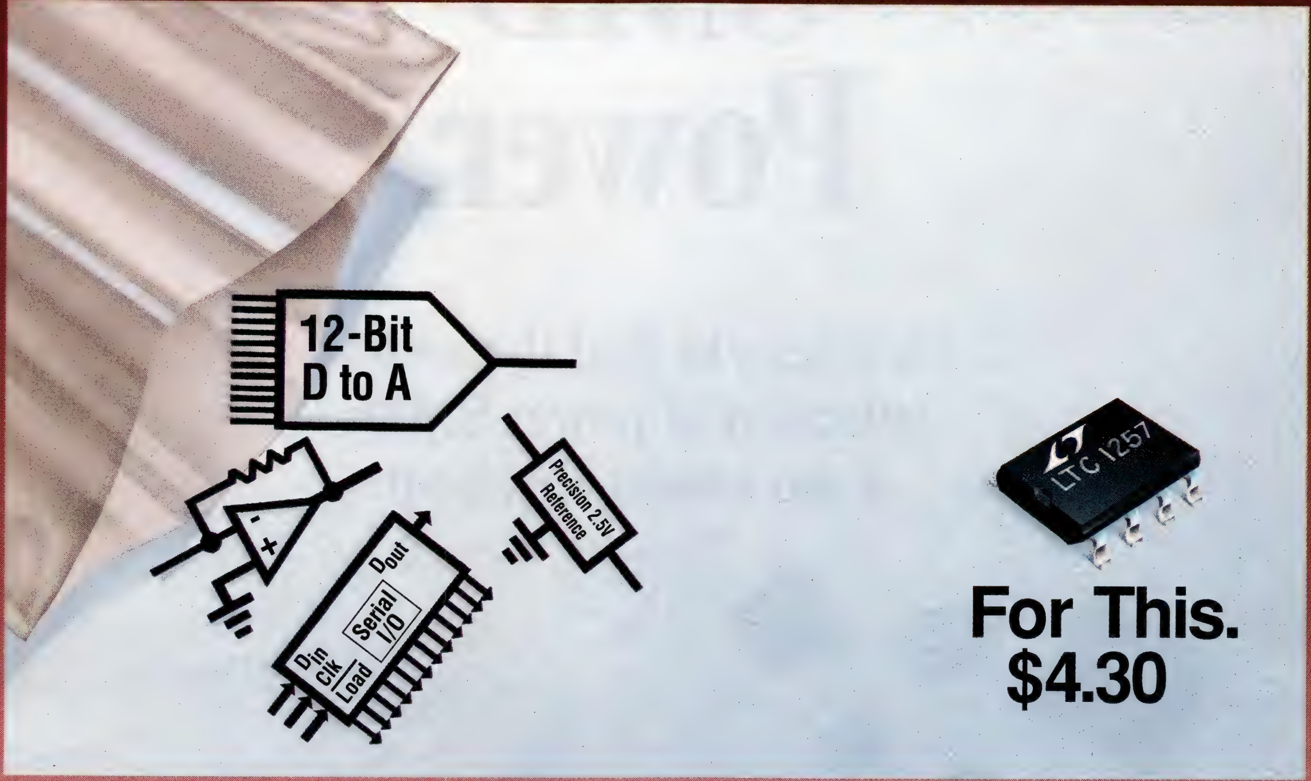
Complete Solutions – Easy to Integrate. VersaPoint technology offers unprecedented options for integration into a wide variety of products. The thin profile and simple construction enables these pointing devices to fit almost anywhere! Complete solutions include all the sensor, mechanical, hardware and software components you'll need. When you integrate VersaPoint technology into your next product, you'll reduce design and production costs an save valuable development time.

Interlink Electronics –
The Experts in Man-Machine Interfaces.
Interlink Electronics offers a complete range of computer pointing solutions for virtually any application. Select from "drop-in" OEM modules complete products or custom solutions. We're your "one stop" source for cursor and machine motion control. Our staff of skilled engineers is ready to assist you with all facets of your design and integration. Call us today at (805) 484-1331.

All products and brands named are trademarks of their respective companies

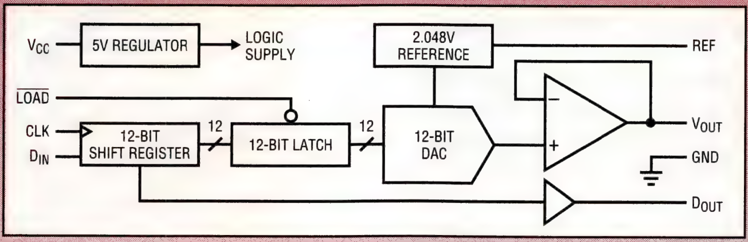
CIRCLE 118 FOR U.S. RESPONSE CIRCLE 119 FOR RESPONSE OUTSIDE THE U.S.

All This. In This.



The LTC1257. Complete 12-Bit Serial SO-8 DAC.

Using a 12-bit DAC is now easier than ever! The new LTC1257 is a complete 12-bit DAC in a very small 8-pin SO package. No external components are needed. And the price may be the easiest thing of all! Included is an output buffer amplifier, a 2.048V voltage reference and an easy to use cascadable three-wire serial interface.



The power supply current is a very low 350µA typ. when using a 5V supply. Excellent differential non-linearity—less than 1/2 LSB—guarantees monotonicity and makes the LTC1257 ideal for control and adjustment applications. And you get flexibility—the single supply voltage can go from 4.75 to 15.75 volts and you can override the internal reference to extend the output range as high as 0-12 volts.

The DAC's small size and low power consumption make it ideal for battery powered systems. And with the cascadable serial interface, applications using multiple DACs are a breeze. So if you want to reduce your system cost and complexity, the LTC1257 is a natural choice. Parts are available in 8-pin SO packages or 8-pin DIP. Pricing in 1000-up quantities starts at $4.30. For more details, contact Linear Technology Corporation, 1630 McCarthy Blvd., Milpitas, CA 95035/408-432-1900. For literature only, call **1-800-4-LINEAR.**

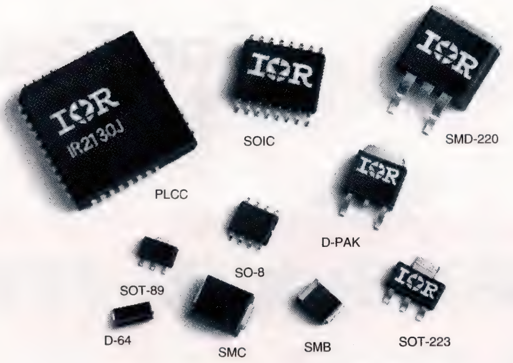
LINEAR
TECHNOLOGY

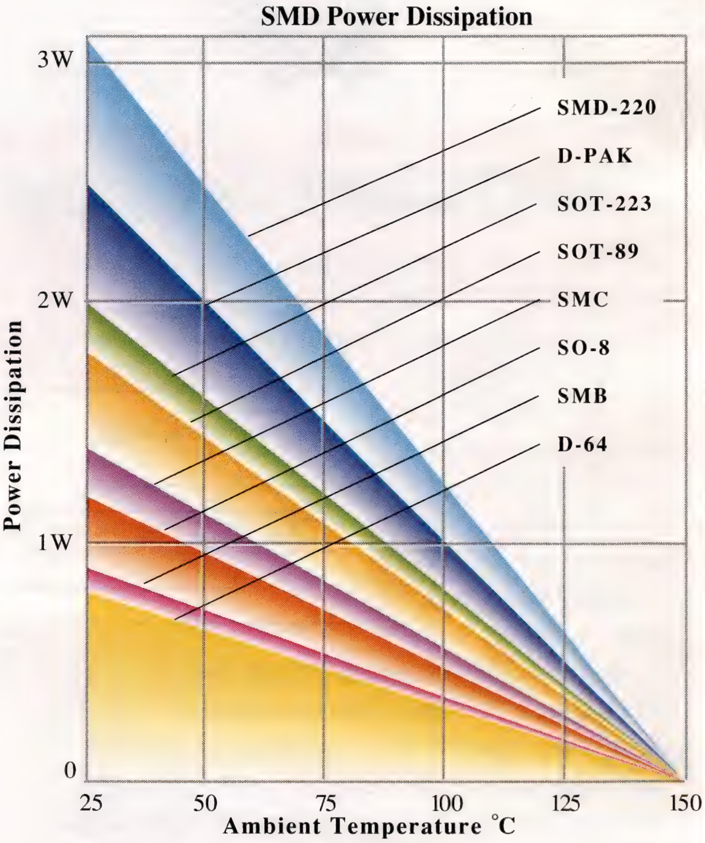
FROM YOUR MIND TO YOUR MARKET
AND EVERYTHING IN BETWEEN.

CIRCLE 248 FOR U.S. RESPONSE **CIRCLE 249 FOR RESPONSE OUTSIDE THE U.S.**

SMD Power.

Or where to find the widest selection of power SMDs at the lowest cost/amp.





Small as they are, our power SMDs save you more than just board space. They save you time. And money. With the best price-performance ratio from the widest choice of SMDs available.

All off the shelf. All under one roof. And value-priced at the lowest cost/amp. From HEXFET® power MOSFETs and IGBTs to their drivers, the IR2100 Series. And, of course, Schottkys.

You'll find no other power SMDs so closely matched in features and capabilities. But don't take our word for it. Send for our "SMD Power Pak" by fax. Or call. 310-322-3331, ext. 2529.

You'll be surprised at what you save.

Available now at key IR distributors.

International Rectifier

WORLD HEADQUARTERS: 233 KANSAS ST., EL SEGUNDO, CA 90245, USA 310-322-3331, FAX 310-322-3332, TELEX 66-4464. EUROPEAN HEADQUARTERS: HURST GREEN, OXTED, SURREY RH8 9BB, ENGLAND, (0883) 713215, FAX (0883)714234

CIRCLE 238 FOR U.S. RESPONSE

CIRCLE 239 FOR RESPONSE OUTSIDE THE U.S.

TECHNOLOGY NEWSLETTER

FIELD-EMISSION SCHEME YIELDS COLOR PANELS

With diagonals of 4 to 6 in., the first *color* flat-panel field-emission displays (FEDs), developed by Pixel International, Rousset, France, promise designers several benefits over standard passive or active LCD technology. FEDs consume little power and are relatively simple to manufacture because the emitters consist of an array of etched, microscopic, cone-shaped elements called microtips. They also have wide viewing angles with CRT-like viewing quality, operate over a wide temperature range, and have a low material cost. The latest panel capabilities, demonstrated last month at the Stanford Resources Flat Information Displays Conference in Santa Clara, Calif., will lead to panels with a contrast ratio between 10 and 20 in an ambient light of up to 500 lux. The intrinsic contrast ratio is set via biasing points on the cathode element and the modulation voltage (about 30 V to get an on/off current ratio of about 100). Red, green, and blue pixel elements are deposited on the rear of the panel's glass anode, through which the display is viewed. Sandwiched between each of the three color phosphor elements in the pixel and the glass anodes are the isolated electrodes. By properly biasing the color electrodes and a gate electrode, individual colors or a blend can be generated at each pixel site. Pixel expects to offer 4-to-6-in. monochrome and color FEDs by the fourth quarter of 1994, 10-in. VGA-resolution units by mid 1995, and XGA-quality units by mid 1996. Contact Dr. Francis Courreges at (33) 42 23 10 00. *DB*

MCC LAUNCHES STUDY OF OPTO INTERCONNECTS

Lower-cost fiber-optic interconnects for short-distance data communications is the ultimate goal of a technology study spearheaded by the Microelectronics and Computer Technology Corp. (MCC), Austin, Texas. The project's objective is to make available to its participants, by 1996, the technology and suppliers for low-cost optical data links for moderate to high bit rates. Participants in the Phase I technology study include AT&T, Computing Devices International, Hughes Aircraft Co., and others. A Phase II effort, planned as a two-year development project, is expected to launch in the first quarter of 1994. Participation is still open to other companies. Call MCC at (512) 343-0978. *DM*

PROCESS PRODUCES NEAR-PHOTOGRAPHIC QUALITY

Makers of wax color thermal-transfer printers will soon be able to implement a new variable thermal-transfer process that produces near photographic-quality images. The VT2 process, developed by Fujicopian Co. Ltd. of Japan, makes it possible to control variable dot sizes while maintaining 300-dot/in. and 4-bit/pixel resolution. This compares with today's fixed-process printers that typically feature a resolution of just 1 bit/pixel. The VT2 process, which also doubles the speed of the printer output, incorporates a thinner color-thermal-transfer ribbon containing a higher pigment concentration. The company claims that the technique also should find its way into multimode printers, where one or more wax thermal-transfer processes would reside in the same printer. Then, the imaging output could match the application, resulting in the lowest cost per page. Contact the Association of Color Thermal Transfer Technology (ACT) at (716) 691-5817. *RN*

MOTOROLA LICENSES ITS BALL-GRID-ARRAY PACKAGE

The ball-grid array's (BGA's) proliferation as an alternative to quad flat packs (QFPs) is now being furthered by a licensing agreement between Motorola Inc., Phoenix, Ariz., and ASAT Ltd., Hong Kong. Under the agreement, ASAT gains full production rights to assemble BGA packages using existing and future Motorola patents pertaining to its overmolded pad-array carriers (OMPAC). ASAT plans to offer the first of these packages, the 225-ball OMPAC, in mid-1994. The 169- and 313-ball versions will follow soon after. Customers will be able to use ASAT's design and characterization lab (in San Jose, Calif.) for application-specific requirements. Call ASAT at (602) 945-1987. *DM*

APM SPECIFICATION GETS REVISED

The Advanced Power Management (APM) specification, originally released a year ago by Intel Corp., Santa Clara, Calif., and Microsoft Corp., Redmond, Wash., has been updated: APM version 1.1 improves the power-management software on Intel-architecture platforms. APM will offer increased battery life for portable systems and reduced power consumption for today's energy-conscious desktop platforms. Using the new specification, the operating system communicates with the BIOS to initiate power reductions to various system resources. The release adds support for the Plug and Play initiative, which makes PCs easier to configure and use. This means that power-management

POWER SPLITTERS/ COMBINERS

the world's largest selection
2KHz to 10GHz from 2^{95}

With over 300 standard models, from 2-way to 48-way, 0°, 90° and 180°, 50- and 75-ohms, covering 2KHz to 10GHz, Mini-Circuits offers the world's largest selection of off-the-shelf power splitter/combiners. And, with rapid turnaround time, we'll also supply "special" needs, such as wider bandwidth, higher isolation, lower insertion loss and phase matched ports.

Available for use in military and commercial requirements, models include plug-in, flat-pack, surface-mount, connectorized standard and custom designs. New ultra-miniature surface mount units provide excellent solutions in cellular communications, GPS receivers, Satcom receivers, wireless communications, and cable systems.

All units come with a one-year guarantee and unprecedented "skinny" sigma unit-to-unit and production run-to-production run repeatability. All catalog models guaranteed to ship in one week. Mini-Circuits...dedicated to exceed our customers' expectations.

finding new ways...
setting higher standards

Mini-Circuits™

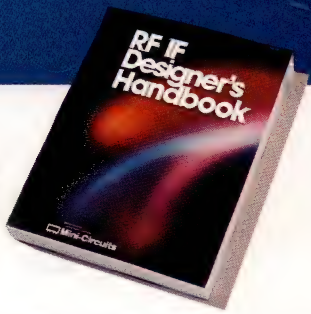
WE ACCEPT AMERICAN EXPRESS AND VISA

P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661

Distribution Centers/NORTH AMERICA 800-654-7949 • 417-335-5935 Fax 417-335-5945 EUROPE 44-252-835094 Fax 44-252-837010

F134 Rev D

CIRCLE 132 FOR U.S. RESPONSE CIRCLE 133 FOR RESPONSE OUTSIDE THE U.S.



For detailed specs on all Mini-Circuits products refer to
• THOMAS REGISTER Vol. 23 • MICROWAVES PRODUCT DIRECTORY
• EEM • MINI-CIRCUITS' 740-pg HANDBOOK.

reductions to various system resources. The release adds support for the Plug and Play initiative, which makes PCs easier to configure and use. This means that power-management information will travel between applications, device drivers, and the operating system. Version 1.1 is completely backward-compatible with the original specification and will be supported by future versions of Windows. The specification (order number 241704) can be obtained by calling Intel's Literature Center at (800) 548-4725, or from Microsoft's Hardware Vendor Relations group (order number 781-110-X01) at (206) 882-8080. *RN*

WAFER-SCALE DESIGNS FOCUS ON PRACTICALITY

Digital signal processing, imaging arrays, and highly parallel computers are just some of the practical applications of wafer-scale technology that will be addressed at the upcoming 1994 IEEE Conference on Wafer Scale Integration, Fairmont Hotel, San Francisco, Calif., Jan. 19-21. One system that combines DSP and front-end analog-to-digital conversion will be described by a team of close to ten companies and universities. The system consists of a set of data-acquisition modules, which are part of the front-end readout microsystem (FERMI). FERMI was developed for high-speed data collection for particle physics experiments. Wafer-scale technology is the only approach that appears practical because the data-collection system may need as many as 50,000 channels. Performing DSP algorithms from a 512-kbyte static RAM, a 23-by-13-mm DSP chip employing about 26 million transistors will be described jointly by Westinghouse Electric Corp., MIT's Lincoln Laboratory, and Analog Devices. A multigigabit switch for asynchronous-transfer-mode (ATM) systems, developed by Washington University, will round out the application section. The switch can handle a clock speed of 100 MHz and uses byte-wide data paths to achieve a data throughput of 800 Mbits/s. For registration information or program details, contact Terry Chappell at (408) 662-1936 (phone and fax). *DB*

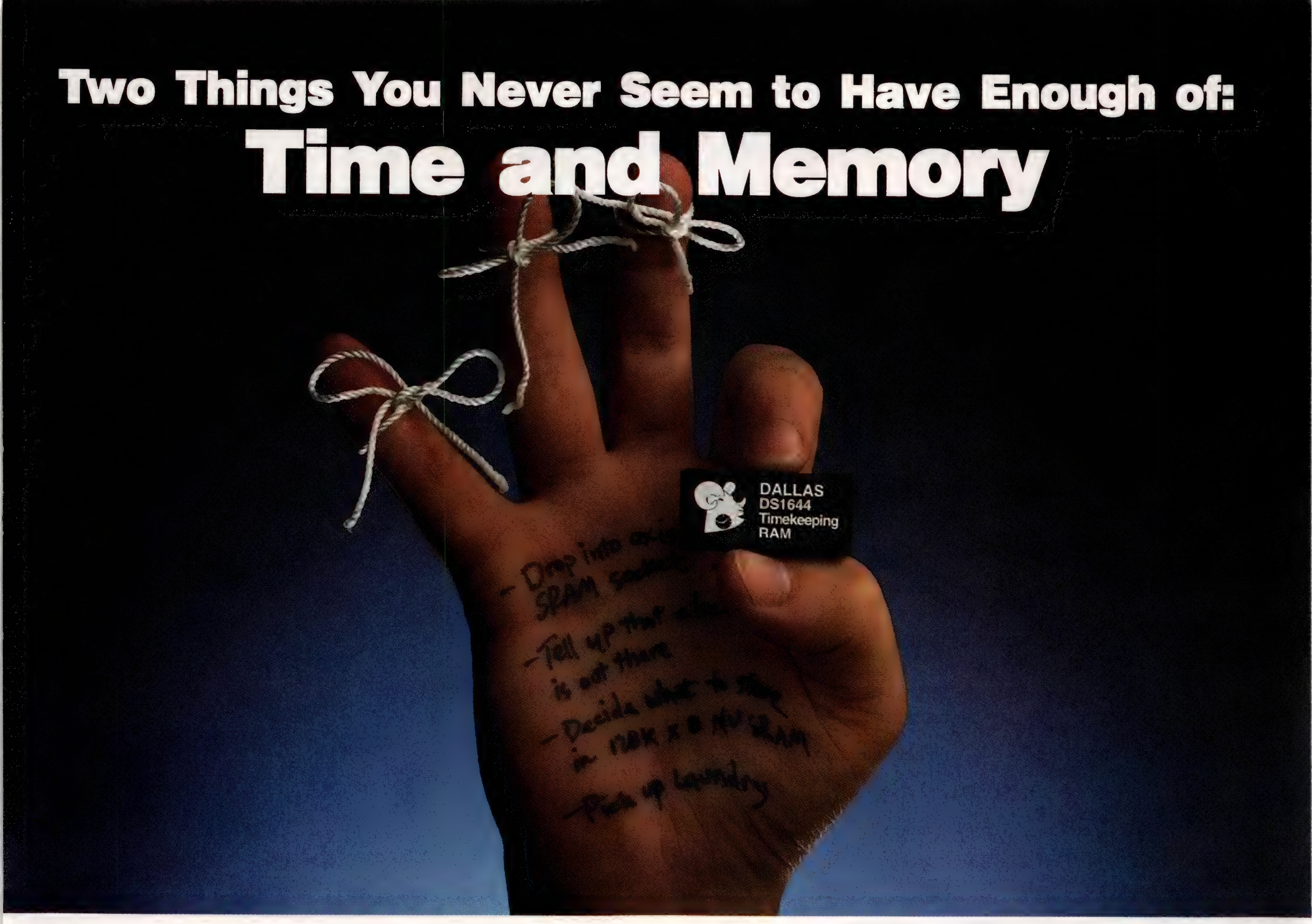
INTERFACE SPEC LINKS MODELS TO SIMULATORS

The Software Interface Technology (Swift) specification is a universal interface that links behavioral models to both commercial and proprietary simulators. Swift consists of an application programming interface (API) that specifies a standard set of commands for accessing and interacting with the SmartModel Library from Logic Modeling Corp., Beaverton, Ore. The specification is the result of nearly two years of collaboration among electronic-design-automation (EDA) vendors to streamline the model translation and validation process. AT&T, Cadence Design Systems, Mentor Graphics, Synopsys, and Viewlogic are just a few of the companies that have adopted the new specification. Swift is simulator-independent, and extensible to support new applications and features. A detailed Swift specification and the associated integration software lets EDA application developers tightly mesh the Swift commands into their tools, and easily customize how users interact with models for particular applications. For more information, call Logic Modeling at (800) 344-0004. *LM*

OBJECT-ORIENTED OS EMPOWERS APP CREATION

The Solaris enterprise system software developed by Sun Microsystems Computer Corp., Mountain View, Calif., will be able to make use of the NextStep application environment from NeXT Computer Inc., Redwood City, Calif., thanks to a joint agreement between the two companies. At the same time, NeXT will open up NextStep by freely licensing the application programming interfaces (APIs) and the OpenStep trademark to all independent implementations that pass an OpenStep test suite. Behind NextStep is NeXT's object-oriented core software technology that Sun expects will drive many of the new enterprise-computing applications. It also promises to accelerate the creation of new applications, increase their reliability, and allow the reuse and leverage of software components. The agreement calls for NeXT to publish an interface specification, OpenStep, which is based on the operating-system-independent layers of NextStep release 3.2 APIs. With the interface specification, applications that only use the APIs will be portable across multiple OpenStep implementations, regardless of the underlying operating system. The specification is targeted for release by June 30, 1994, and will be submitted to various standards organizations (the Object Management Group and X/Open, for example). Sun's license of NextStep will lead to an implementation of the OpenStep specification for the Solaris distributed object environment (DOE). NeXT also will port the native NextStep operating system to the Sparc architecture. On top of that, the company licensed SunSoft's networking and distributed object technologies, including the common object request broker architecture (CORBA), the Object Management Group's interface definition language, and the network file system. *DB*

Two Things You Never Seem to Have Enough of:
Time and Memory



Not to worry; we've got plenty of both. Introducing the DS164x Timekeeping RAM series, real-time clocks combined with nonvolatile RAM in a single, space-saving package.

Because you probably have stuff you want your system to remember along with the time, the DS164x series offers a whole range of memory densities. Starting at 2K bytes and going all the way up to 128K, with even larger densities coming soon. Now your customers can upgrade systems in the field with higher NV RAM densities if the software requirements grow more complex. (And they always do.)

Because all packages are JEDEC-compatible, they can be easily plugged into ROM, EPROM, and EEPROM sockets. And presto! Suddenly your system knows the time, along with configuration data, setup info, number and type of add-in boards, resident software … whatever you need.

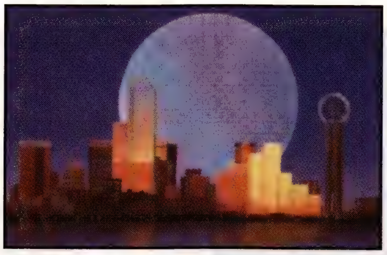
Timekeeping RAM Series

Device Number	NV RAM	Package Type	Direct Replacement for
DS1642	2K x 8	24-Pin Dual-In-Line	48T02
DS1643	8K x 8	28-Pin Encapsulated DIP	48T08
DS1644	32K x 8	28-Pin Encapsulated DIP	**Nothing, Zip, Nada. Nobody else offers densities this high.**
DS1646	128K x 8	32-Pin Encapsulated DIP	

Thanks to a self-contained lithium energy source, the clock and NV RAM retain data over 10 years in the absence of system power. Which is longer than the useful life of most equipment.

Timekeeping RAMs incorporate the real-time clock registers in the uppermost eight bytes of the memory map. These registers provide year, month, date, day, hours, minutes, and seconds data in 24-hour BCD format. They correct for day of the month and leap year automatically.

If you could use more time and memory, give us a call.



DALLAS
SEMICONDUCTOR

4401 South Beltwood Parkway • Dallas, Texas 75244 • Telephone: 214-450-0448 • Fax: 214-450-3715

CIRCLE 169 FOR U.S. RESPONSE CIRCLE 170 FOR RESPONSE OUTSIDE THE U.S.

SHARP

PROGRESS REPORT

Dedicated to the proposition that one good idea leads to another.

Fifty years ago, getting the "big picture" at home depended mostly on your powers of imagination. But the pictures to be delivered to homes within this decade may exceed what all but the most ardent futurist *ever* imagined.

The TV set is the most likely point of confluence for all the innovations in information exchange now converging on the home market, with every media from video disks to fiber optic highways jostling for position. At Sharp, we've always been partial to the path of least resistance — the airwaves — ever since we created and marketed the first mass-produced crystal radio sets back in 1925.

You might be surprised at the number of areas in which Sharp continues to be the pacesetter in wireless communications components. Whether your transmission is in RF or IR bandwidths, by terrestrial or satellite broadcast, across the continent or across the room, here's why it pays to have Sharp go to bat for you.

H/V linear and R/L circular polarization LNBs from Sharp provide superior cross-polar discrimination, plus a waterproof, airtight structure which ensures reliable performance in the most severe conditions.

A FINE LINE OF RF COMPONENTS, FINE-TUNED TO YOUR NEEDS.

For years, Sharp has led the field in the miniaturization, noise reduction and seamless integration of RF components, from Ku band LNBs — the industry's smallest — to 22cc DBS tuners. The breadth of Sharp's line and our ability to custom-configure help us meet your size, packaging or power requirements readily.

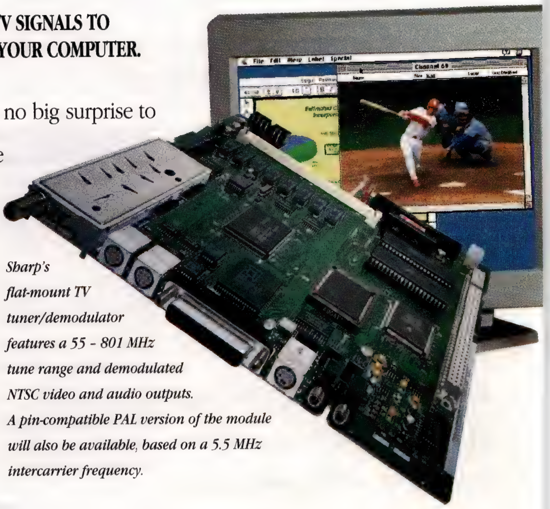
Sharp's ultra-compact DBS tuners — with their advanced designs, reduced component count and low power consumption — contribute to smaller system sizes and have established new paradigms for reliability and integration.

As North American DBS comes into its own, we'll be there to bring home whole *new* generations of products supporting, for example, the transmission of multiple signals and vast home programming options — the products of *your* imagination.

From the crystal radio to the wire

WE BRING TV SIGNALS TO THE HEART OF YOUR COMPUTER.

It should come as no big surprise to see that Sharp, the world's leading manufacturer of RF components, is one of the first to deliver a TV tuner/demodulator in a flat-mount package offering easy integration in system design.



Sharp's flat-mount TV tuner/demodulator features a 55 - 801 MHz tune range and demodulated NTSC video and audio outputs. A pin-compatible PAL version of the module will also be available, based on a 5.5 MHz intercarrier frequency.

It's the start of a whole new ballgame. Manufacturers of desktop and portable PCs gain immediate entry into video and multimedia — two arenas where tuner size, mounting and power requirements precluded their entry until now. And because this is a complete component module, they can avoid design and development at the subassembly level — always an enviable competitive edge.

ess revolution: we're pulling the future out of thin air.

SHARP IS ON YOUR WAVELENGTH IN THE IR SPECTRUM, TOO.

Sharp is the first company to deliver market-ready technology for short-range high-speed infra-red data transmission. Small size, low cost, low power consumption, immunity to EMI and no FCC licensing requirements make Sharp's IR product series a key player in a nearly limitless range of new applications, from personal communications systems to wireless joysticks and interactive TV. Transmission units providing ranges up to 3 meters, higher data rates and 3-volt operation are soon to follow as Sharp continues to evolve its expertise and experience in IR communications.

Sharp's RY5 Series includes receiver, transmitter and bi-directional IR units. They support 38.4kb transmission rates over a 1-meter range, operate from a 5V source, and can be readily interfaced with existing digital circuitry.

FREE! SHARP'S LATEST RF COMPONENTS CATALOG, WITH NO STRINGS ATTACHED.

Sharp's RF Components Short Form Catalog will show you a huge range of capabilities, sizes and packaging options indicative of our customer focus and cutting edge expertise. It's yours free, just for calling.

And the fact is, your best connection is Sharp whether your venture calls for high-end digital signal processing, the power to store hundreds of pages of graphics within the smallest possible space, uncompromising flat panel display quality, or a manufacturer uncommonly committed to responding to your own design ideas.

For more information, simply contact your nearest Sharp Electronics Corporation sales office or call us at **1-800-642-0261, Ext. 902.**

SHARP®

**FROM SHARP MINDS
COME SHARP PRODUCTS™**

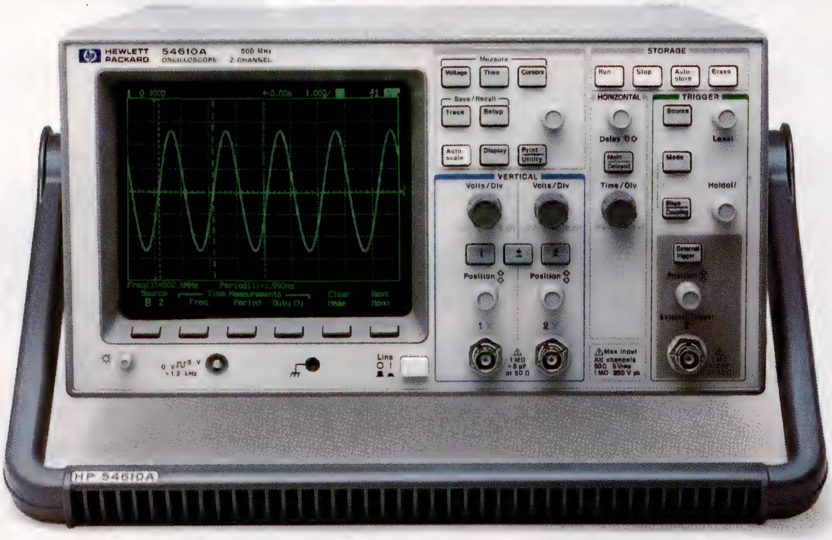
FOR MORE INFORMATION CALL SHARP AT 1-800-642-0261 EXT. 902

opyright © 1993 Sharp Microelectronics Group.

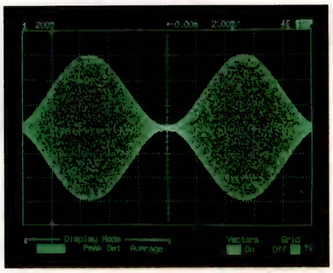
CIRCLE 173 FOR U.S. RESPONSE CIRCLE 174 FOR RESPONSE OUTSIDE THE U.S.

SEC-1093

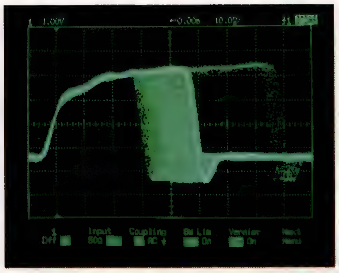
The best thing about our 500 MHz scope isn't the low price.



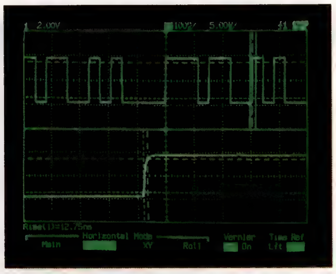
It's what you get for it.



Just like an analog scope, HP's 500 MHz oscilloscope has a real-time display that responds instantly to changes in your waveforms or controls.



A bright trace and convenient, push-button functions like Autostore let you easily see and store tough-to-find signals.



Pretrigger viewing and delayed sweep mode help you save time by grabbing and displaying signals before or after the trigger event.

© 1993 Hewlett-Packard Co. TMPMO345/INTL

How we can offer you a 500 MHz, delayed sweep scope that's within budget, without compromise.

High bandwidth digital scopes have always forced you to sacrifice two things you love about analog scopes: a familiar look and feel and immediate, believable displays.

Our engineers didn't think you should have to make that compromise. So they designed the HP 54610A oscilloscope with the analog-style interface you're comfortable with, and a new digital architecture that produces waveform displays superior to analog scopes.

The result: you get the quality and performance you'd expect from HP. At a price you wouldn't.

Call HP to see how much scope you can get for your money.

Discover just how easy it is to afford a high bandwidth, high accuracy oscilloscope by calling your local HP sales office or one of the numbers listed below. Once you hear the price, we think you'll agree it's the best deal of any 500 MHz scope.

In fact, you can learn more about the HP 54610A scope's sweep speed, time base accuracy, digital storage and any other specifications you may need to make the right decision by talking to your local HP field engineer.

So give us a call. And discover how much more you really get from HP today.

There is a better way.

HEWLETT PACKARD

CIRCLE 114 FOR U.S. RESPONSE

CIRCLE 115 FOR RESPONSE OUTSIDE THE U.S.

Australia (008) 033-821 • France (1) 69-82-65-00 • Germany (06172) 16-1634 • Hong Kong (852) 848-7070 • India (11) 463-2379 • Italy (02) 9212-2241 • Korea (2) 769-0800 • Netherlands (020) 547-6669 • PRC (1) 505-3888 • Singapore 291-8554 • Spain 900 123-123 • Sweden (08) 750-20-00 • Switzerland (057) 31-21-11 • Taiwan (2) 717-9524 • United Kingdom (0344) 362867

INTERPRETER BRIDGES U.S. NAVY COMPUTER'S UYK SOFTWARE TO VME COMPUTER PLATFORMS

The U.S. Navy's UYK-7, 20, 43, and 44 shipboard computers typify the older generation of computers that rely on proprietary hardware and are hampered by closed architectures and lagging performance. Though MIL-STD-2036 allows the specifying of commercial off-the-shelf hardware for many military systems—letting the Navy's "gray box" computers be replaced by VME-board-based hardware that's built around a new crop of high-speed reduced-instruction-set (RISC) processors—UYK-executable code simply won't run on VME-based platforms.

As a result, software developers face a daunting choice: millions of lines of software application code must be reengineered to preserve an estimated $25 billion investment; or applications must be developed anew for the RISC processors, an equally staggering task in terms of time and money.

One solution would be to implement an emulator built around VME hardware. Yet, depending on the approach employed, emulation as an option would not perform well in the Navy's mission-critical, real-time situations if recompiling was required.

Now VisiCom Laboratories Inc., San Diego, Calif., has come up with what it considers a better alternative—VisiBridge. Employing this process, the company rehosted programs written in UYK-executable code to VME RISC-processor platforms.

Although it's primarily aimed at the U.S. Navy's ship-board military computers, the VisiBridge interpreter could also be applied to other computers in which large amounts of software make software-code conversion very expensive and time-consuming.

Switching to commercial VME boards will ultimately shrink the size, weight, and cost of computer systems. At the same time, power-consumption levels are reduced, mean-time-between-failure (MTBF) rates are improved, mean-time-to-repair (MTTR) statistics are lengthened and reliability is increased.

Using VisiCom's proprietary software interpreter, supported by design and debugging tools, UYK code can be rehosted at the binary level to run—without the need for recompiling—on a wide variety of target computer platforms.

Addressing the importance of real-time operation, the VisiBridge interpreter segments performance-critical elements of the rehosted application program. As a result, those time-critical elements can be run on a dedicated VME processor that resides on the same backplane as the primary rehost processor.

Within the rehost processor, virtual UYK entities like registers, memory, and I/O paths are created. These are called by the VisiBridge interpreter to implement UYK executable code.

The chief attribute of the VisiBridge interpreter is its ability to operate line by line on binary object instructions, determine the equivalent UYK operation, and then implement the identical operation in the instruction set of the host RISC processor. As a result, basic instructions like Add, Shift, and Jump On Compare can execute about as fast as those in UYK. More important, though, the high operating speed of new RISC processors enables complex instructions, particularly floating-point math operations, to run several hundred times faster than on the UYK system.

What's more, the VisiBridge interpreter allows for new programs written in Ada, C, and C++ languages to be added to the suite of applications that run on the VME computer platform. The rehosted software and its VME computer platform become a bridge between the UYK system and the new hardware.

Connectivity to U.S. Navy workstations, such as the DTC-2, TAC-3, and the upcoming TAC-4, allow the considerable assests of these systems to act in a support or supervisory manner, further enhancing the VisiBridge interpreter's rehosted-system's capabilities.

With the VisiBridge interpreter, critical portions of the rehosted UYK code can be rewritten in native machine code of the VME-based processor. Rewriting may be done as needed to create a constant upgrade path to newer computer platforms.

Another advantage of VisiBridge is that it can configure virtual I/O devices: The system can use commercial off-the-shelf-available peripherals that appear to the application as mil-spec devices. This leads to saving on cost and weight as well as improving reliability and performance.

Because any VME-compatible board may be implemented in a VisiBridge rehosted system, communication between VisiBridge elements takes place over the VMEbus. This in turn enhances multiprocessing configurations.

In much the same way, parts of the VisiBridge system can be interconnected to external equipment by the Fiber Distributed Data Interface (FDDI), Ethernet, the Small Computer Systems Interface (SCSI), or any other VME-board protocol. These interconnections not only afford high bandwidth, but also save on hundreds of pounds of cable typically used for UYK interconnection.

Finally, the rehosted system features better I/O response. VisiCom's Antares Group developed I/O processor cards that supply dedicated and intelligent I/O ports, boosting response time for servicing I/O functions. This improves on the original gray boxes that relied on a single dedicated I/O controller to service up to 16 UYK-20 and UYK-44 ports, or 32 (UYK-43) Navy Tactical Data System (NTDS) ports.

In rehosting applications, VisiBridge requires that developers understand and analyze the software to be rehosted. Some software may be in written UYK assembly language, CMS-2, or standard Navy operating systems, such as the AEGIS Tactical Executive System (ATES). Software that's hardware-dependent needs special attention in order to meet requirements for execution times.

For more information on the VisiBridge interpreter, contact VisiCom Laboratories Inc. at (619) 457-2111; fax -0888.

SHERRIE VAN TYLE

HIGH-DENSITY DRAMS, FAST 64-BIT CPUS, COMMUNICATIONS ICS SPOTLIGHT THE ISSCC

Putting half a billion components on a chip is no mean feat, but at next month's International Solid State Circuits Conference, three Japanese companies will detail their 256-Mbit dynamic-RAM designs. That trio is among the many other outstanding presentations, plenary papers, and evening panel sessions at this year's conference, to held Feb. 16-18 at the San Francisco Marriott Hotel.

Close to two dozen papers will focus on low-power technology, while other presentations will detail supercomputers on a chip, 64-Mbit flash memories, advanced communications circuits operating at frequencies of several gigahertz, and high-speed analog-to-digital and digital-to-analog converters (ADCs and DACs) for video and multimedia (more in-depth ISSCC coverage will be provided in our Feb. 21 issue).

Described in Session 8, the trio of DRAMs were developed by Mitsubishi Electric Corp., Itami; Matsushita Electric Industrial Co. Ltd., Osaka; and Oki Electric Industry Co. Ltd., Tokyo. Mitsubishi's memory chip, fabricated on a 0.25-µm process and able to access data in a mere 34 ns, measures just 13.32 by 22.84 mm. The chip employs a boosted sense-ground scheme that reduces the sub-threshold leakage current through the cell-access transistors by a factor of 10, increasing cell data-retention time.

Cutting the access time to just 10 ns with special serial I/O ports, Matsushita's DRAM includes a refresh-free FIFO buffer that can be used to store moving images. Also fabricated with 0.25-µm minimum features, the memory chip consumes just 73 mA thanks to a suppressed high-level differential transfer scheme, data-bus precharging, and a divided array that reduces active current and improves access time.

Going to synchronous operation, designers at Oki divided their DRAM into 32 banks. They added cache distributed through the sense amplifiers, and tag memory was distributed through the row decoders. As a result, the cache-based memory can deliver data at rates of up to 125 Mbytes/s. To minimize internal delays, the DRAM's designers employ a bank interleaving scheme plus pulse transmission and low-noise current sensing.

Additional memory papers in the same session detail the use of a silicon-on-insulator process to build a 64-kbit DRAM fabricated with 0.5-µm CMOS on a 100-nm-thick SOI film. Although the access time and cell size are not at the leading edge of the performance curve, the SOI structure does markedly reduce the secnsitivity of the cell to soft errors.

The remaining papers in the session examine flash-memory technology, with Intel Corp., Folsom, Calif.; NEC Corp., Sagamihara, Japan; and Mitsubishi describing 3.3-V chips with densities of 16 Mbits, 64 Mbits, and 16 Mbits, respectively. NEC's 64-Mbit chip is the largest flash memory to date. It accesses in just 50 ns and is divided into small blocks of just 256 bits that can be erased or programmed independently. To make the programming easier, designers at NEC created a dynamic bit-line latch and employ hierarchical word- and bit-line structures on a chip measuring 19.3-by-19.3 mm and fabricated on a process with 0.4-µm mimimum features.

In Intel's flash memory, an interleaved page buffer is used to improve the programming time, and a command queue allows the memory chip to hold up to three commands for execution. Furthermore, a read request takes priority over erase/write operations and will temporarily suspend those operations to read the desired data. In Mitsubishi's flash, the company's designers added a Gray-code scheme to the memory's row decoder to program out defective word lines and improve yield.

Although not pure memory, an experimental neural-MOS multiple-valued memory technology described in the same session was developed at Tohoku University, Sendai, Japan. The approach will be applied to intelligent data-processing applications that require data association and classification.

Taking advantage of the large and fast memories will be a new generation of 64-bit and even 32-bit processors to be detailed in Session 12. For starters, Intel's Processor Div., Hillsboro, Ore., will detail its 3.3-V, 0.6-µm implementation of the Pentium processor. This version, thanks to four levels of metal interconnections to trim chip area, will consume just 8 W at 100 MHz. The chip will also include clocking schemes that support fractional bus-to-core ratios and selective power down.

Clocking its chip at 75 MHz externally, but 300 MHz internally, Toshiba Corp., Kawasaki, Japan, in conjunction with Silicon Graphics Inc., Mountain View, Calif., will detail a supercomputer on a chip. The processor can deliver 300 MIPS and 300 MFLOPS using a four-issue superscalar architecture implemented with 2.6 million transistors. Also on tap is Hewlett-Packard Co.'s (Cupertino, Calif.) new implementation of its Precision Architecture, which clocks at 140 MHz. The 64-bit processor includes a multiprocessor bus that can transfer data at 768 Mbytes/s. It packs a 2-kbyte fully-associative miss cache as well as a dual-integer data path, and performs single-cycle loads and stores to the primary cache.

Additional presentations in the same session include a 64-bit MIPS-compatible processor developed by MIPS Technologies Inc., Mountain View, Calif., which delivers a throughput of 55 SPECint while dissipating less than 2 W—about 1/6 the power level of

WANT TO GO?

The 1994 International Solid State Circuits Conference (ISSCC) will be held February 16-18 at the San Francisco Marriott Hotel, San Francisco, Calif. For registration details, contact Diane Suiters at Courtesy Associates, 655 15th St., N.W., Suite 300, Washington, D.C. Call (202) 639-4255; or fax: (202) 347-6109.

GAMMA... A New DAP Generation

The GAMMA series

Cambridge Parallel Processing's GAMMA series of Deployable Massively Parallel Computers will be featured on an upcoming segment of *ComputerWatch.*

Delivering twice the computational performance and twice the memory of the previous DAP generation in less than half the space, the DAP GAMMA series is the fourth and newest generation of DAP systems. With performance up to 7.5 GFLOPs on 8-bit data and 1.1 GFLOPS on 32-bit data, DAP GAMMA dramatically expands the capabilities of deployable super-performance computers. The GAMMA series can operate as a stand-alone computer or can be attached to contemporary workstations or network servers manufactured by Sun, HP or DEC.

COMPUTER Watch

The television series

For more information please call:

CA (714) 261-8901

or fax (714) 724-8399.

ComputerWatch is a weekly television series designed to give first hand information on the latest developments, issues and trends in the computer marketplace. For more information please call: Dale Britte (305) 421-2226.

All products names are trademarks or registered trademarks for their respective owners.

The GAMMA series can be seen on *ComputerWatch* – airing this winter on CNBC at 4:00 E.S.T.

CIRCLE 96 FOR U.S. RESPONSE
CIRCLE 97 FOR RESPONSE OUTSIDE THE U.S.

previous R4000-series processors. IBM Corp., Essex Junction, Vt., will describe its latest PowerPC processor, the 603, which has a 32-bit data path but dissipates just 1.3 W. The PowerPC processor employs fully-static CMOS logic, which permits the clock circuit to be shut off during power-down periods. Clock-doubling logic can acquire a new input frequency in just two cycles. Consequently, the processor frequency can be adjusted dynamically. A second IBM presentation will detail another processor that is capable of delivering performance levels of 75 SPEC92int/85 SPEC92fp while dissipating just 3 W.

The fastest processor to be described, a 500-MHz 32-bit RISC core developed by NEC, employs both an 8-stage pipeline with a register file that accesses in 1.8 ns and a two-stage pipelined cache. Fabricated with 0.4-µm design rules, the CMOS circuit contains just 200,000 transistors.

Specialized processors also will be heavily represented at this year's conference. In Session 13, a neural-network processor developed by Mitsubishi contains a dozen 24-bit floating-point units that deliver an aggregate throughput of 1.2 GFLOPS. In Sessions 4 and 5, several video processors—such as MPEG-2 video decoder ICs from Toshiba and Matsushita—will be detailed. So will a Toshiba family of 200-MHz video-compression macrocells, and a configurable 25-Mpixel/s video-compression processor created by the University of California at Los Angeles. Philips Research Laboratories, Eindhoven, the Netherlands, will unveil in the same session a low-power chip set for portable multimedia applications, as well as a low-power error-correction circuit for digital compact cassettes.

The field of wireless communications, one of the hottest subjects in the industry, will also take part of the spotlight. Two sessions (Sessions 2 and 6) are wholly given to wireless and high-speed communications, and a third session will focus on optical communications (Session 10). A full-day short course covering the fundamentals of wireless technology will be provided on Feb. 19. In Session 2, an integrated transmitter RF IC, designed jointly by the Hewlett-Packard Co. and Ericsson GE Mobile Communications, Research Triangle Park, N.C., is targeted at digital cellular handsets. It combines an offset voltage-controlled oscillator and a synthesized local oscillator, plus it includes monolithic 900-MHz filtering. The transmitter delivers a +9-dBm signal at a 1-dB compression point, provides 40 dB of sideband and carrier suppression, and possesses a 1.2:1 output VSWR (Voltage Standing Wave Ratio).

A one-chip 40-MHz-to-2-GHz single-superheterodyne receiver will also be unveiled by Siemens AG, Munich, Germany. This chip includes an RF mixer, a 115-MHz limiter with 80-dB dynamic range, a coincidence demodulator, a sample-and-hold circuit, and an analog baseband filter. The bipolar circuit operates from 3 V, and has a 6-dB mixer gain and a –4-dBm third-order intercept point. Pushing biCMOS up to 6 GHz, a differential phase-locked loop (PLL) developed by AT&T Bell Laboratories, Holmdel, N.J., and Allentown, Pa., can operate at supply levels as low as 2 V. Described in Session 6, the PLL, including I/O buffers, dissipates just 60 mW and has an rms jitter of just 3.1 ps at 6 GHz.

For use in optical data lines, Toshiba will unveil a set of five aluminum-gallium-arsenide (AlGaAs) heterojunction bipolar transistor ICs it developed for 20-Gbit/s optical data links. Presented in Session 10, the chip set provides all of the functions for a 20-Gbit/s optical transceiver—the laser driver, a 20-GHz decision circuit, an 18-GHz bandwidth transimpedance amplifier, a 21-dB-gain line receiver, and a 20-GHz retiming circuit. Working in silicon, designers at NEC have developed a two-chip set for an optical receiver operating at 20 Gbits/s. The chips, also described in the session, employ transistors with cutoff frequencies of 60 GHz.

Although GaAs-based circuits offer some of the highest speeds, silicon is improving—a 13.4-GHz divider fabricated in a 0.1-µm CMOS process by AT&T Bell Laboratories, Holmdel, N.J., uses ring-shaped transistors to greatly reduce source-drain junction capacitances. The 1/2 divider dissipates just 28 mW when operating at 13.4 GHz from a 2.6-V supply. Delivering the widest bandwidth of just about any amplifier—0.1 to 75 GHz—a circuit based on indium-phosphide (InP) high-electron-mobility transistors was created as part of a joint effort between Hewlett-Packard Laboratories, Palo Alto, Calif., and Hughes Research Laboratories, Malibu, Calif. The circuit consists of a three-stage shunt-feedback amplifier with 17-dB gain from 100 MHz to 75 GHz.

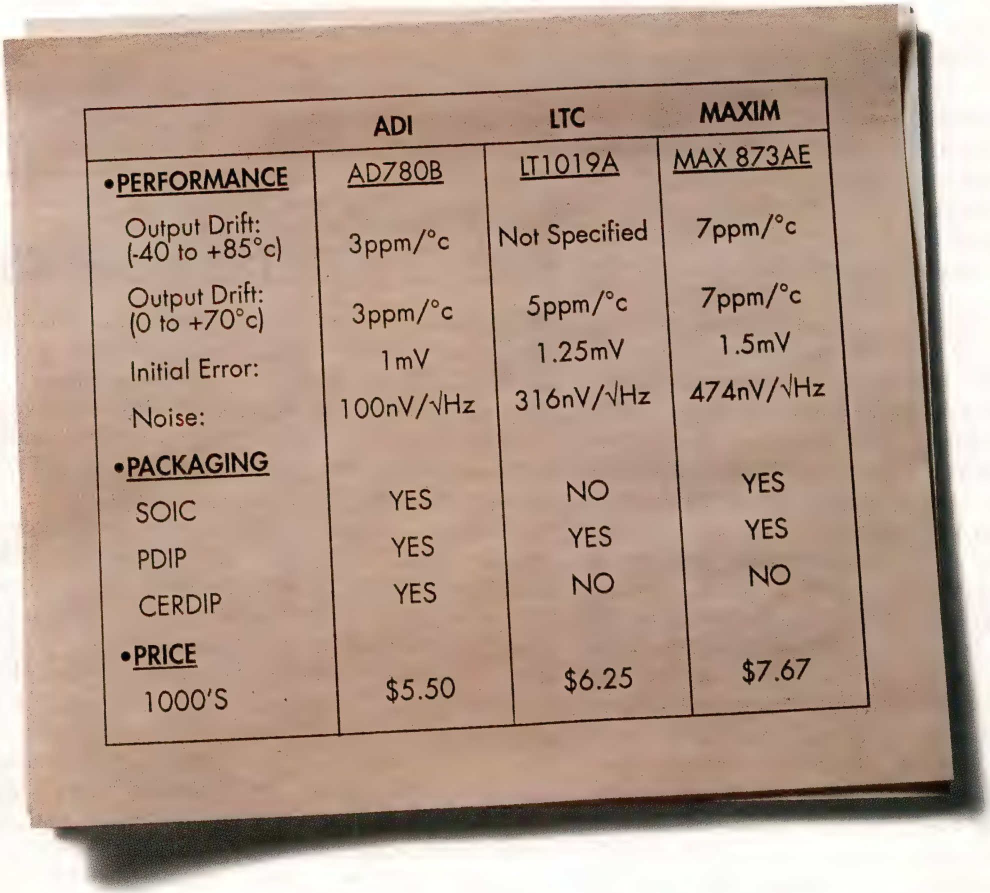
High-speed ADCs and DACs are also benefiting from process and architecture advances, as can be seen from a trio of presentations in Session 3. Philips Research Labs, Eindhoven, the Netherlands, came up with a 1-Gsample/s 10-bit DAC implemented in a bipolar process. Another presentation involves a 320-MHz CMOS triple 8-bit DAC with an on-chip PLL and a hardware cursor, developed by Analog Devices Inc., Norwood, Mass. The third presentation covers a 10-bit 20-Msample/s 3-V CMOS ADC from Mitsubishi. It's intended as a macrocell for use in system VLSI circuits.

Two unusual converters will be revealed in Session 9. The first is a 15-bit electromechanical sigma-delta converter developed by CSEM, Neuchatel, Switzerland. It employs a micromachined accelerometer to form the first stage of a sigma-delta converter with an 80-kHz sampling frequency. Electrostatic force balances the acceleration, letting the sensor achieve a nonlinearity of just 0.1% for forces in the ±1-g range.

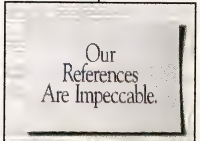
The other converter is actually a 17-bit, 32-channel charge-readout circuit implemented in biCMOS that consumes just 240 mW. The circuit, developed by Case Western Reserve University, Cleveland, Ohio; General Electric Medical Systems, Waukesha, Wis.; and General Electric's Corporate Research and Development Laboratory, Schenectady, N.Y., achieves 13-bit precision and 4-bit gain control in 32 charge-to-digital converters that feature a 50-ms conversion time. A compression curve can be stored in an off-chip lookup table.

DAVE BURSKY

When it comes to performance, packaging and price, our references are impeccable.



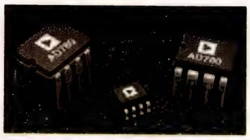
	ADI	LTC	MAXIM
•PERFORMANCE	AD780B	LT1019A	MAX 873AE
Output Drift: (-40 to +85°c)	3ppm/°c	Not Specified	7ppm/°c
Output Drift: (0 to +70°c)	3ppm/°c	5ppm/°c	7ppm/°c
Initial Error:	1mV	1.25mV	1.5mV
Noise:	100nV/√Hz	316nV/√Hz	474nV/√Hz
•PACKAGING			
SOIC	YES	NO	YES
PDIP	YES	YES	YES
CERDIP	YES	NO	NO
•PRICE			
1000'S	$5.50	$6.25	$7.67



Whether you're specifying 2.5V, 5V or 10V, Analog Devices offers an unbeatable family of monolithic, high-precision voltage references available in either surface-mount or through-hole packaging, over the industrial temperature range.

Introducing the AD780. The world's best performing 2.5V reference.

When it comes to voltage references, the AD780 is truly superlative. It's the highest precision 2.5V voltage reference on the market. In fact, with its temperature coefficient of 3ppm/°C and initial accuracy of 1mV, no other voltage reference comes close to its performance over the industrial temperature range. It has by far the lowest noise in its category and at just $5.50 (in thousands) for the B-grade and $3.30 (in thousands) for the A-grade, it's also the lowest priced. But the AD780 isn't merely superlative, it's completely unique. It's the only reference capable of providing either a 2.5V or 3.0V output while maintaining the industry standard pinout. Incidentally, the AD780 also offers the versatility of being available in industrial grade, surface-mount packaging. All of which means if you're seeking a truly superlative voltage reference, the AD780 is one reference you should check. So call your nearest ADI representative listed below for a free sample and datasheet.



ANALOG DEVICES

Analog Devices, Inc. European Headquarters: Munich (089) 57005 0 **Austria:** (222) 88 55 04 0 **Belgium:** (3) 237 16 72 **Denmark:** (42) 84 58 00 **France:** (1) 46 66 25 25, 76 41 91 83 **Germany:** 089 57 005 0, 030 391 90 35, 04181 80 51, 0221 68 60 06, 0711 88 11 33 **Israel:** (052) 91 14 15 **Italy:** (2) 66 500 120, (11) 24 82 176, (6) 86 200 306 **Netherlands:** (1620) 815 00 **Sweden:** (8) 282 740 **Switzerland:** (1) 820 01 02, (21) 803 25 50 **United Kingdom:** (0932) 25 33 20, (0932) 23 22 22

CIRCLE 88 FOR U.S. RESPONSE **CIRCLE 89 FOR RESPONSE OUTSIDE THE U.S.**

DIGITAL-CONTROL SCHEME REMOVES CRT DISTORTION

A novel digitally-based control scheme will help improve CRT-display convergence, color uniformity, and brightness uniformity. Developed by Philips Consumer Electronics Co., Knoxville, Tenn., it's claimed to be better than conventional analog control because it removes CRT-beam distortions and misconvergences across the entire screen, leading to sharper and brighter images.

Images tend to get distorted at the edges of a large CRT display due to nonlinearities encountered as beam angles change from the central viewing area on the display. In the new scheme, a special circuit and magnetic sensor are included to automatically compensate for changes in ambient magnetic fields (such as those that occur when a monitor is moved to another desk or is turned).

The digital control logic, which is embedded in the monitor, is used during the manufacturing process to allow people on the manufacturing line to quickly "tune" each monitor so it produces a perfect image. Digitally-generated waveforms produced in the monitor do the tuning. These signals are optimized by taking measurements at many points across the screen and then adjusting the digital waveform for optimum operation at each point.

Consequently, each monitor has its own unique internal control waveforms to deliver optimum images out to the far corners of the screen. The control scheme also includes an externally accessible RS-232 port, allowing users to perform subsequent reoptimizations as a monitor ages.

In contrast, traditional analog-based monitors can only provide an average correction of properties, such as brightness and color characteristics across the screen. Furthermore, the controlling analog signal is usually determined and assigned (preset) during the monitor's design phase—the signal is formulated by averaging anticipated individual component and manufacturing variations.

Because the digital waveforms that control the beam current aren't preset in the new scheme, a simple test setup can be used to set the optimal signals for perfect displays once the monitor manufacturing process is completed. And because the tuning is done after the monitor is manufactured, it can take into account all manufacturing and component-value variations.

Typical examples of performance improvements include a beam misconvergence of as little as 0.15 mm—about half that of other analog-based monitors. Also, brightness uniformity of close to 90% can be achieved (versus about 75% for an analog monitor).

A similar improvement is possible for color uniformity—X and Y color coordinates change no more than ±0.006 over the entire screen (versus about±0.015 for analog-controlled monitors). Finally, the white-color temperature, which in traditional monitors is fixed at one value, is user-selectable thanks to the digital control circuitry to provide precise color matching. Users can set the monitor for either 6500K or 9300K settings, or set a user-defined value by adjusting the RGB drive settings.

This control scheme is incorporated into the Brilliance 2130, a 21-in. monitor unveiled by Philips at last November's Comdex Conference in Las Vegas, Nev. The monitor can display images of up to 1600 by 1280 pixels with a 0.28-mm pitch.

Microprocessor-based control circuits have 14 preset modes and 8 user-programmable modes. A small backlit LCD panel provides information about the display settings, and displays the parameters during tuning. All of these optimal-monitor-performance features don't come for free, though—the suggested price for the 21-in. monitor is $3499.

For more information, contact John Strobel at (615) 521-4490.

DAVE BURSKY

CROSSPOINT SWITCH BOOSTS MULTIPROCESSORS

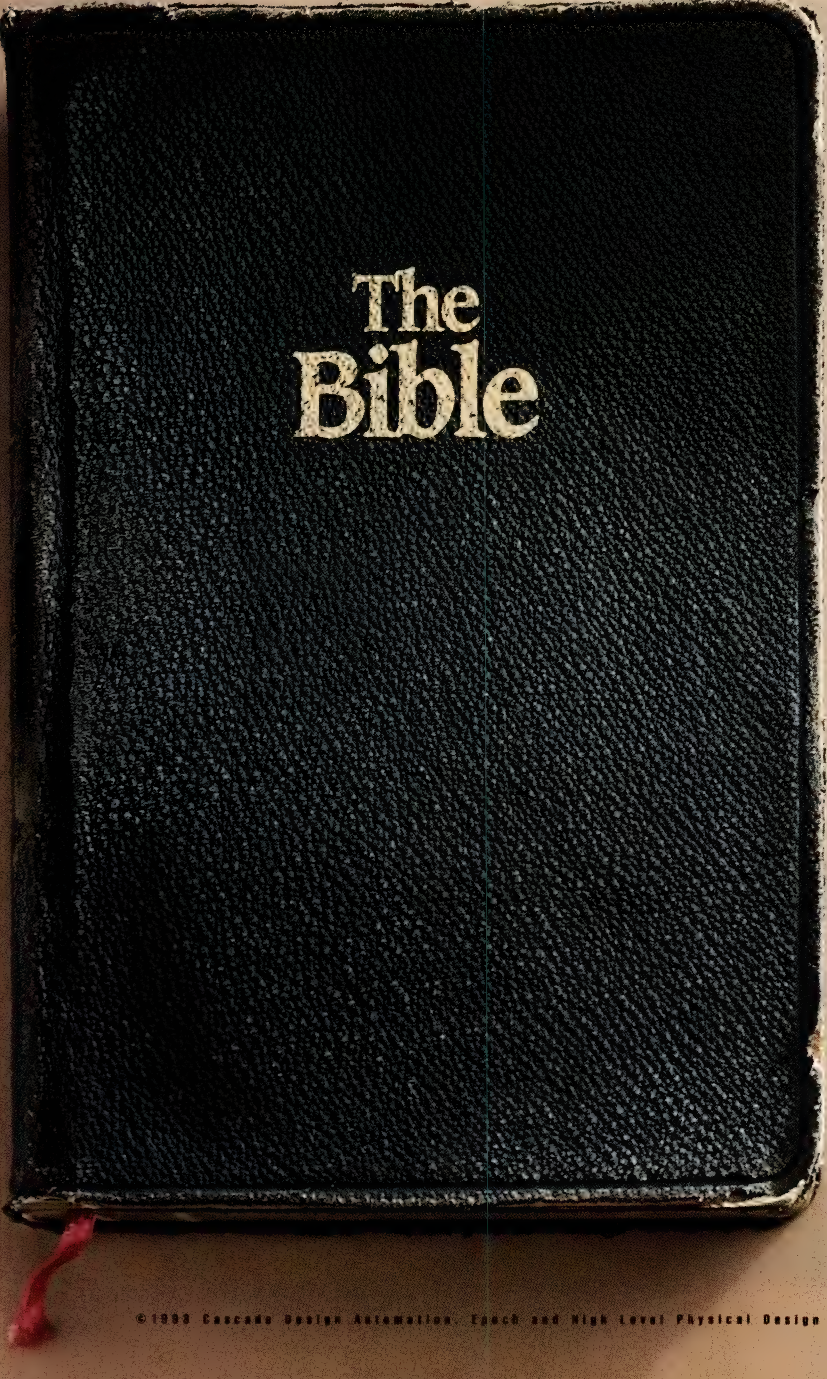
Because today's PCs are typically built with 33- or 66-MHz 486 microprocessors, the PC may be more suited to handle a printer's computations, such as imaging and rasterizing, than the printer itself. In other cases, the processing load can be shared. With the WinStyler, a newly developed hardware-software combination, that balanced processing can happen, ultimately improving the printer's performance. It also handles bidirectional parallel and serial communications between the printer and host computer.

Designed by Destiny Technology Corp., Santa Clara, Calif., the WinStyler allows 600-dot/in. laser printers to run in either a Windows or Macintosh environment. Because the imaging is handled by the host, the problems associated with the various printer languages are reduced. In addition, high-speed print jobs in both the Windows and Mac environments can be processed simultaneously by the WinStyler ASIC, which is called the QuickASIC. The graphical-device interface (GDI) software can rasterize and send 600-dot/in. images to the printer at speeds commonly associated with 300-dot/in. data, which is less complex. Because the bulk of the processing is done on the host PC, the platform is capable of some functions that previously weren't available. This is where the software part of the combination comes in: Rather than have users rely on the simple interface offered by the printer, all communications between users and the printer can be handled through the PC itself, producing the GDI. For example, if there's an error within the printer, such as a paper jam or no paper, a detailed message would appear on the PC's monitor, complete with instructions on how to rectify the situation. That wouldn't be possible on today's printers that have a very limited display, or none at all.

Standalone printers based on the WinStyler technology should be available in the second or third quarter of 1994 for under $700. Networked units are due in late 1994. For more information, call Destiny at (408) 562-1000.

RICHARD NASS

The Next Time They Swear Their Physical Design Tools Can Perform Miracles, Make Them Swear On This.



You've heard it all before. Integrated EDA tools that magically give you finished back end design. True performance-driven layouts with your eyes closed. Complex submicron ASICs out the door in no time flat.

Dig a little deeper and you'll find that most of these claims simply won't stand up in court. And after paying a high price in multiple iterations, NRE and scrambled schedules, you'll be ready to swear an oath of your own.

Here's the whole truth and nothing but the truth: Only Epoch™ gives you true High Level Physical Design.™ It's a unique, standards based system that's having the same impact on back end design that synthesis is having on the front end. It fully supports VHDL and Verilog, and it's compatible with other popular design environments.

Epoch is a seamless, completely automated solution. As you work top down, it produces bottom-up physical design. With all the performance and accuracy you need, even for complex layouts below .5 micron. And about ten times faster than anything you've seen before. Just think about what that can do to your time-to-market (or maybe even your next review).

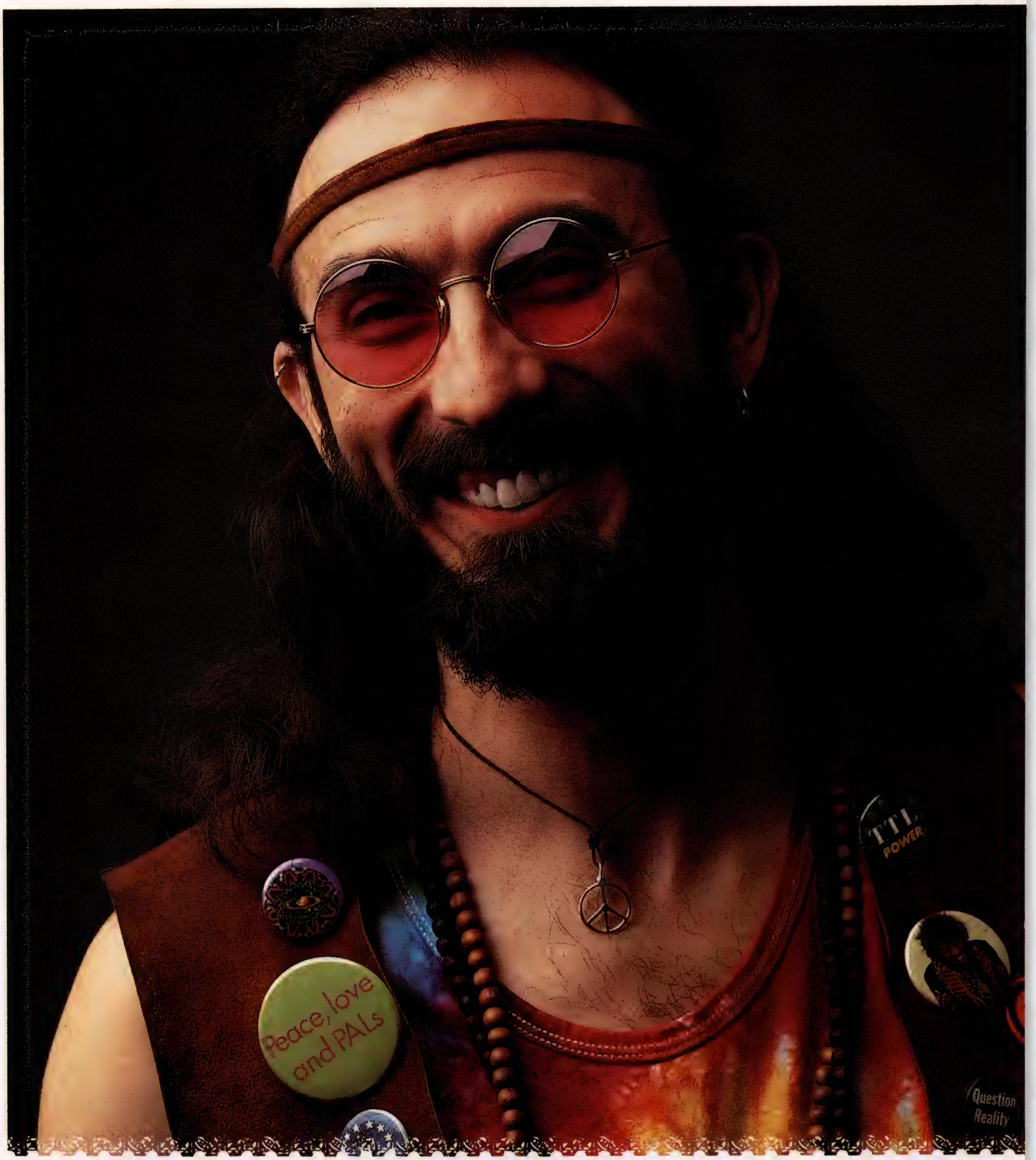
Now if you're still a little skeptical, we understand. All we ask is a chance to present our case. Call us at 800-258-8574 (Department M4) for a brochure. Then you can judge for yourself.

CASCADE
DESIGN AUTOMATION

©1993 Cascade Design Automation. Epoch and High Level Physical Design are trademarks of Cascade Design Automation.

CIRCLE 181 FOR U.S. RESPONSE CIRCLE 182 FOR RESPONSE OUTSIDE THE U.S.

Introducing the new EPLDs from Xilinx. Because products for the next generation shouldn't be designed with parts from the last.



When it comes to design engineering, you only have two choices.

Make history.

Or become history.

So while we have nothing against PALs or TTL, may we suggest something a bit more up to date?

Something that'll meet the hurry-up-get-it-out-first-and-make-it-smaller-and-faster-with-more-features demands of a whole new generation of products.

Like the new EPLDs from Xilinx.®

Our XC7300 family can do everything your PALs or discrete logic can do and then some.

Xilinx EPLD Benchmarks	
State Machine	83 MHz
Counter	100 MHz
16 bit Accumulator	51 MHz
Memory Decoder	10 nS

Our EPLDs have short pin-to-pin delays. So they're fast. And since they act just like PALs, your design time is cut down to practically no time.

In less space, faster, and with less power.

Just one Xilinx EPLD, for instance, can integrate dozens of devices, very, very quickly. With interfaces for ABEL,™ CUPL,™ and PALASM,™ and software that directly converts and optimizes PAL files, you can use everything you've ever learned.

And just consider what you'll get to work with: terrific speed, totally predictable timing, and guaranteed 100% routing, thanks to our thoroughly modern Universal Interconnect Matrix.™

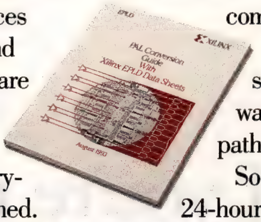
This latest advance allows you to engineer even the most complex functions, which along with higher product term utilization, boosts logic performance.

In addition, our 7300s are the only EPLDs in this day and age with built-in Arithmetic Logic Units (ALUs, for short), so you can build adders, accumulators, and comparators, easily.

Since they also let you incorporate higher level system functions, our EPLDs are perfect for everything from simple controllers to complex synchronous state machines.

You can count on a bright future, too.

Because we're the only company with a simple, straight-forward upgrade path to FPGAs.



So call our 24-hour literature hotline at 800-231-3386 for a copy of our new PAL Conversion Guide and the name of the Xilinx representative nearest you.

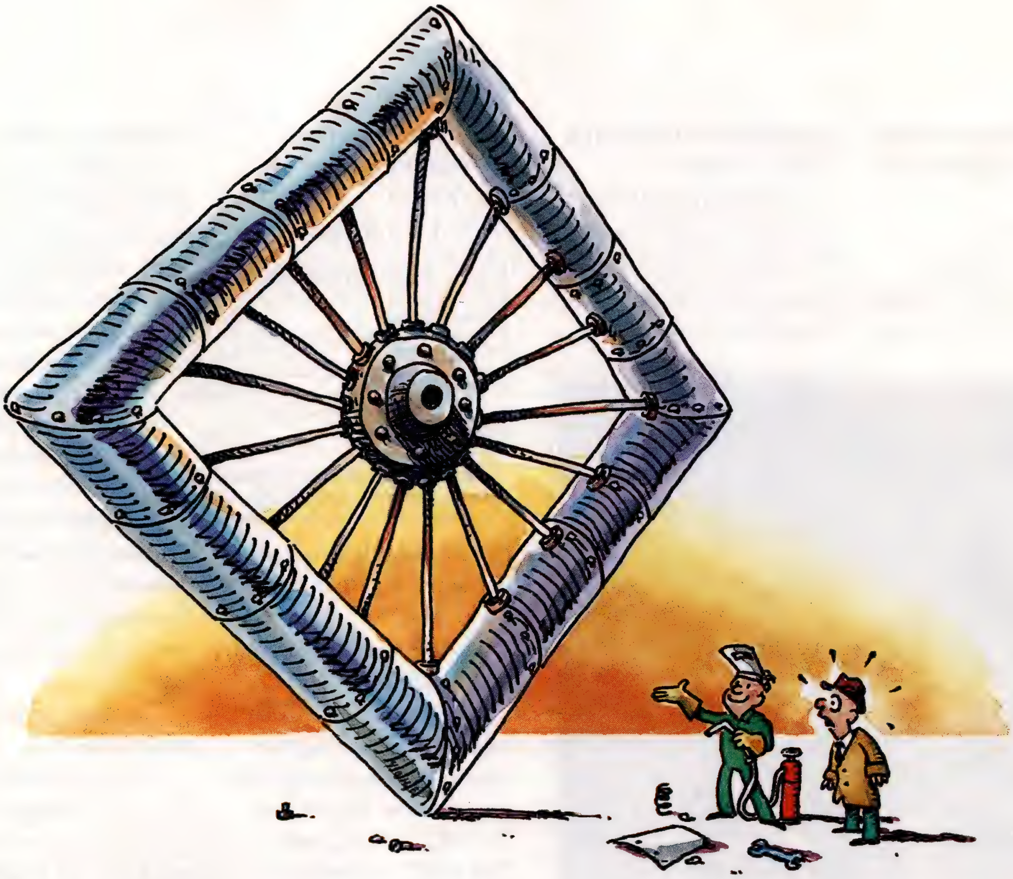
Because the times they are a'changin. And it pays to stay ahead of them.

XILINX®
The Programmable Logic Company.℠

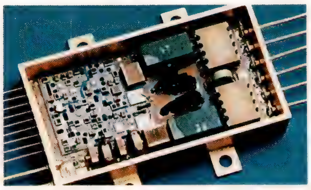
CIRCLE 165 FOR U.S. RESPONSE
CIRCLE 166 FOR RESPONSE OUTSIDE THE U.S.

©1993 Xilinx, Inc., 2100 Logic Drive, San Jose, CA 95124. Europe, 44 (932) 349401; Japan, 81 (3) 297-9191; Asia, 852 (3) 721-0900.

Xilinx is a registered trademark, and The Programmable Logic Company is a service mark of Xilinx, Inc. All other trademarks or registered trademarks are the property of their respective holders.



If you're reinventing the wheel, reinvent it with the right mechanic.



Up to 60W/in³ in a 3.5 oz hermetic hybrid package (1.5"x2.74"x0.4").

Let's face it, you've only got a few vendors to choose from. And even fewer, if you're concerned with total quality. Nobody understands this better than Raytheon's Quincy Operations. Our electronic systems and components are synonymous with total quality. So, if you're inventing new ways to stay competitive, you couldn't ask for a better partner than us.

Consider our high-density power supplies. At up to 60 watts per cubic inch and over 86% efficiency, these DC to DC convertors give you the flexibility of distributed power architecture. Our products include 28Vdc and 270Vdc input models with 50W to 100W power configurations and very low ripple noise. And modified standard products can be designed for telecommunications, space and shipboard applications.

What does all this capability mean? It means we're the perfect choice for your new applications. All Quincy high-density power supplies are hermetically sealed in a hybrid package and are NAVMAT derated. In addition, because our high-density power supplies are all produced in our automated facility, they perform even beyond your expectations.

So if you're positioning your product for the future, Raytheon's Quincy Operations can help you get there. Without us, you may just end up spinning your wheels.

Call or write for technical support and applications assistance: Raytheon Company, Quincy Operations, 465 Centre St., Quincy, MA 02169 (617) 984-8508, FAX (617) 984-4196.

Raytheon

WE THRIVE ON CHALLENGES

CIRCLE 150 FOR U.S. RESPONSE

CIRCLE 151 FOR RESPONSE OUTSIDE THE U.S.

BY DIVIDING A 100-MBIT/S DATA STREAM INTO FOUR 25-MBIT/S STREAMS, A CHIP SET FOR 100BASE-VG NETWORKS TRIMS CONNECTIVITY COST.

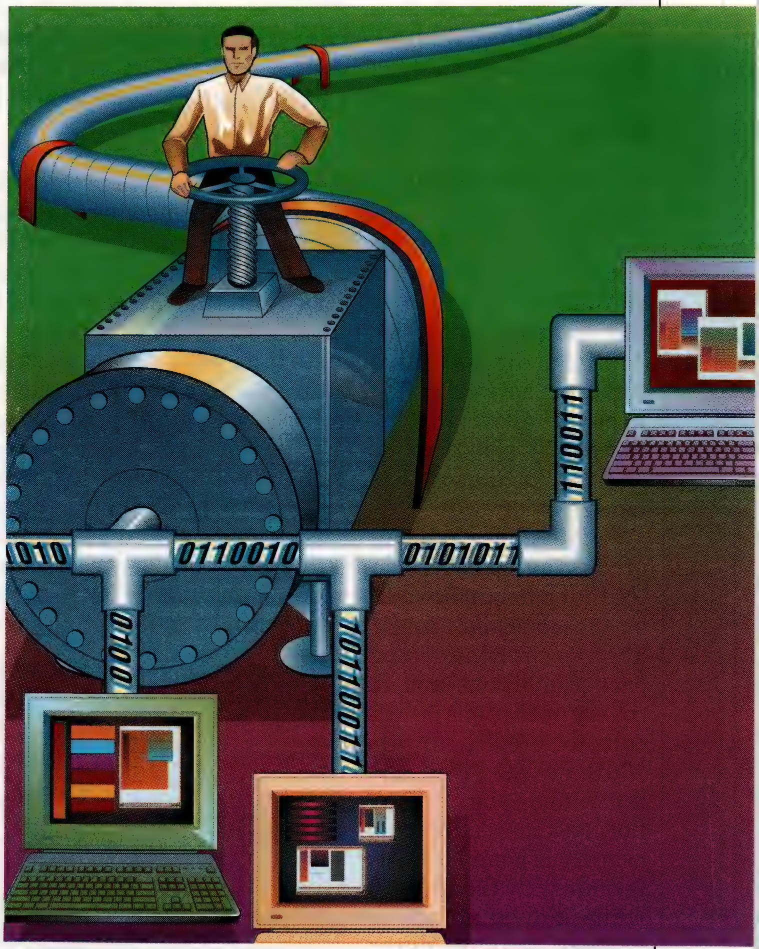
CHIP SET DELIVERS 100 MBITS/S TO THE DESKTOP

DAVE BURSKY

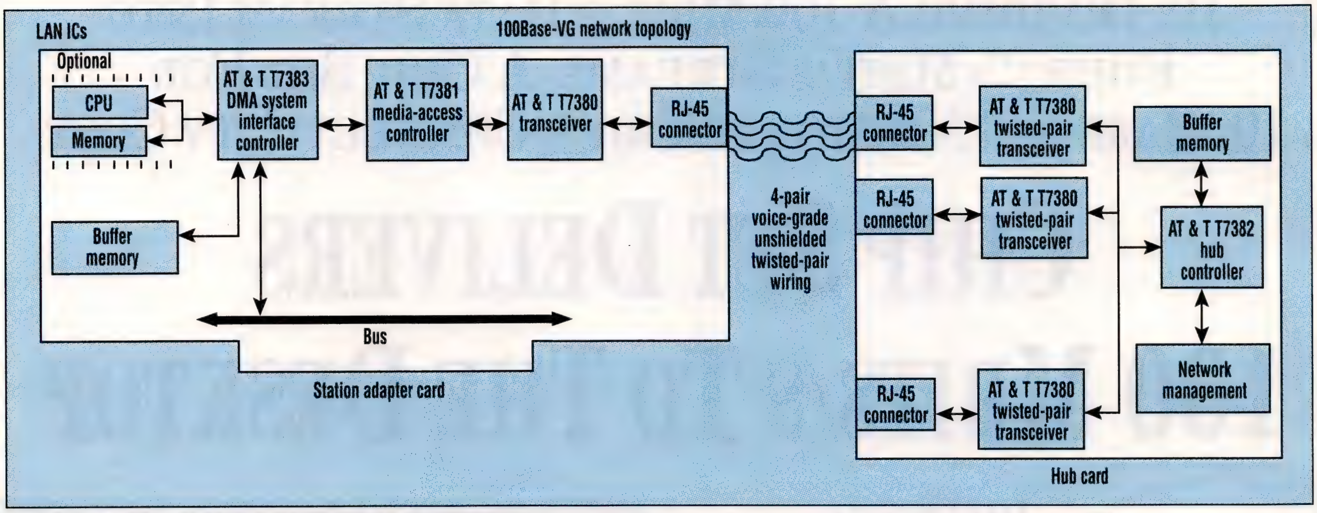
Applications involving the movement of data, images, and multimedia (including videoconferencing) over corporate-wide networks are quickly proliferating into the market. Coupled with this surge, though, is the fact that traditional 10-Mbit/s Ethernet networks are grinding to a halt due to traffic overloads. Higher-speed networking schemes like the 100-Mbit/s (125 Mbits/s when 4B5B encoded) Fiber Distributed Data Interface (FDDI) and its copper cousin, the CDDI, provide some data relief. However, the high cost of an FDDI/CDDI adapter—close to $1000/node plus the optical fiber, or the cost of Category 5 (because they can't run on existing Category 3 wiring) shielded twisted-pair wiring—makes it too expensive for companies to equip all of their computer systems with them.

Over the last few years, a number of firms have found ways to increase the basic 10-Mbit/s data rate of Ethernet while maintaining the same basic protocol *(see the table)*. The results of those efforts have yielded transfer speeds of 100 Mbits/s in the form of 100Base-VG (now referred to as AnyLAN), and the 100Base-X option. Of the two, the 100Base-VG activity, which employs an approach called quartet signaling, is the only high-speed scheme that can run on low-cost Category 3 wiring (unshielded twisted pairs, or UTPs). According to several telecommunications studies, about 60% of the buildings in the U.S. already have such wiring in place.

Several companies do employ closely held custom-chip solutions to implement 100-Mbit options. Now, however, AT&T Microelectronics has developed a commercially available chip set. The chip set allows designers to implement moderate-cost 100Base-VG adapters (IEEE 802.12), bringing 100-Mbit data streams to the desktop. The chip set will support the Ethernet and token-ring frame formats. Furthermore, users will be able to preserve the twisted-pair wiring already in place for 10Base-T networks.



Data transfers can be done at ten times the speed of Ethernet systems and six times that of token-ring networks, at a per-node cost


LAN ICs
100Base-VG network topology
Optional
CPU
Memory
AT & T T7383 DMA system interface controller
AT & T T7381 media-access controller
AT & T T7380 transceiver
RJ-45 connector
Buffer memory
Bus
Station adapter card
4-pair voice-grade unshielded twisted-pair wiring
RJ-45 connector
AT & T T7380 twisted-pair transceiver
RJ-45 connector
AT & T T7380 twisted-pair transceiver
RJ-45 connector
AT & T T7380 twisted-pair transceiver
Buffer memory
AT & T T7382 hub controller
Network management
Hub card

1. INDIVIDUAL STATION ADAPTERS can be implemented with just three of the four chips developed by AT&T—the T7380 transceiver, the T7381 media-access controller (MAC), and the T7383 host-system interface controller (left). Managed hubs also use the transceiver chip, but instead of the MAC chip, they will use the T7382 hub-controller chip. The T7382 is comparable to the MAC, but it can control up to six ports (right).

less than twice that of an Ethernet or token-ring adapter, and one-third that of a CDDI adapter. With UTP wiring, distances of up to 100 m from the hub are possible. The network has an environmental robustness (low bit error rate) similar to that of 10Base-T networks. Two future devices will allow transmission on the two-pair shielded twisted-pair wiring or fiber, further extending the distance from the hub.

In Ethernet systems, users can't predict the packet latency or guarantee that a maximum delay would not be exceeded since much of the overhead resulting from packet collisions and recovery operations is difficult to predict. In the 100Base-VG AnyLAN, the round-robin arbitration scheme of demand-priority is completely deterministic. In addition, while individual packet latency will be determined by system topology and network loading, maximum delay can be determined, guaranteeing that it will not be exceeded.

For example, in a 10 node network, the maximum latency a packet will ever see is 1.2 ms. The minimum latency is 120 µs and the typical latency will be somewhere in between, depending on network traffic. By comparison, the minimum delay for an idle Ethernet network is 1.2 ms; for a busy Ethenet network the latencies increase drastically. Measurements done for network efficiency match the theoretical predictions of 94% for 1514-byte Ethernet frames and 98% for 4500-byte token-ring frames.

The chip set consists of the T7380 twisted-pair transceiver, the T7381 media-access controller (MAC), the T7383 DMA system interface, and the T7382 hub controller. All four are fabricated in the company's 0.9-µm CMOS digital and mixed-signal processes, and can operate from a 5-V supply. Each node requires at least the T7380, T7381, and T7383 chips. The fourth member, the T7382, forms the heart of a managed hub, and can be used with up to six transceiver chips (one for each port) *(Fig. 1)*. To ensure top performance, the front-end design should closely pair the transceiver and media-access controller for minimal signal losses.

The transceiver chip includes four twisted-pair transmitters and four twisted-pair receivers. It features a

A COMPARISON OF COMPETITIVE NETWORKING APPROACHES

	Transmission rate	Media and distance		Application support		Cost* (relative to 10Base-T)	Standard
		Data-grade UTP (Category 5)	Voice-grade UTP (Category 3)	Data	Multimedia (video)		
100-Mbit/s alternatives							
100Base-VG	100 Mbits/s	150 m	100 m	Yes	Yes	15 (projected to 2)	IEEE (proposed)
CDDI	100 Mbits/s	100 m	No support	Yes	Limited	5-10	ANSI (proposed)
FDDI	100 Mbits/s	No support (fiber optics)	No support (fiber optics)	Yes	Limited	7-15	ANSI X319
Traditional alternatives							
10Base-T	10 Mbits/s	100+ m	100 m	Yes	No	1**	IEEE 802.3
Token ring	4/16 Mbits/s	40-100 m	40 m	Yes	No	2-3	IEEE 802.5

* Includes share of hub cost and adapter-card cost, but does not include upgrades to cabling system which will often be required for alternatives that require data-grade copper wiring or fiber optics.
** Current market prices for 10Base-T solutions are about $200 per node (includes a share of the hub plus adapter card).

Note: CDDI = Copper Distributed Data Interface; FDDI = Fiber Distributed Data Interface; UTP = unshielded twisted pair.

TIRED OF HISTORICAL ACHIEVEMENTS?

The shock of the new

The way it used to be, you could get by with one or two ways to get designs from bright idea to workstation screen.

Then the game changed. To get your work done effectively now, you have to be able to use a *variety* of design entry techniques, in different combinations, at different times. Solutions that don't permit this have become as antiquated as stone tablets.

Now you need more. And Viewlogic has what you need.

Have it your way

Viewlogic has discovered an astonishingly simple principle of electronic design automation: you have to give designers the tools they need and the flexibility they want.

For starters, no one gives you more ways to enter a design: VHDL, ABEL, state diagrams, truth tables, schematics — you name it. But even that isn't always enough to get you where you want to go.

So we take it one step further and give you a *completely graphical approach to high-level design*. For example, when you enter designs using state diagrams, VHDL or Verilog HDL code is *automatically* generated. In fact, you can generate VHDL from virtually any of our design-entry alternatives — or move to and from VHDL.

Dynamic design interaction

It's not just how easily you enter a design that counts — it's how fast you get it working. So Viewlogic's design tools go beyond simple design entry and can even help you with the analysis and debugging process as well.

In fact, *all* Viewlogic's tools go "above and beyond the call of duty." They're graphical, interactive, real-time tools that feature "live links" to all other tools in the Viewlogic environment. So the consequences of *all* design changes are displayed across all tools as they occur — no waiting for results until the end of a run.

Viewlogic's tools don't just talk together. They talk to *you*. And what they say helps you get your job done smarter.

To find out more about our design-entry solutions and complete unified multi-methodology approach, call 1-800-873-8439 today or fax us at (508) 480-0882.

VIEW*logic*®

THE REST IS HISTORY

All trademarks and registered trademarks are the property of their respective owners.

CIRCLE 163 FOR U.S. RESPONSE CIRCLE 164 FOR RESPONSE OUTSIDE THE U.S.

monolithic implementation of a quartet-signaling technique developed by Hewlett-Packard and AT&T Microelectronics *(see "A primer on quartet signaling," p. 55)*. The signaling scheme splits data into four parallel streams of 30 Mbits/s each (25 Mbits/s before encoding with the 5B/6B algorithm), with each stream directed onto a single pair of a 10Base-T four-pair UTP cable. Additional circuitry on the 44-lead circuit includes timing recovery and adaptive equalization for each of the four channels.

The MAC circuit implements the 100Base-VG demand-priority MAC-layer protocol, scrambling/descrambling, and 5B/6B encoding and decoding. Demand priority gives Ethernet and token-ring users a new technology with guaranteed bandwidth and bounded latency. As its name implies, demand priority provides a request-response protocol between the hub and each node.

The on-demand capability routes packets on-the-fly from the source to their destination while the bounded latency ensures predictable, fast network response. Furthermore, being able to prioritize packets assures that critical data reaches its destination. Finally, the guaranteed bandwidth certifies that multimedia applications and video conferencing run without any loss of image or sound flow due to late-arriving or out-of-order packets.

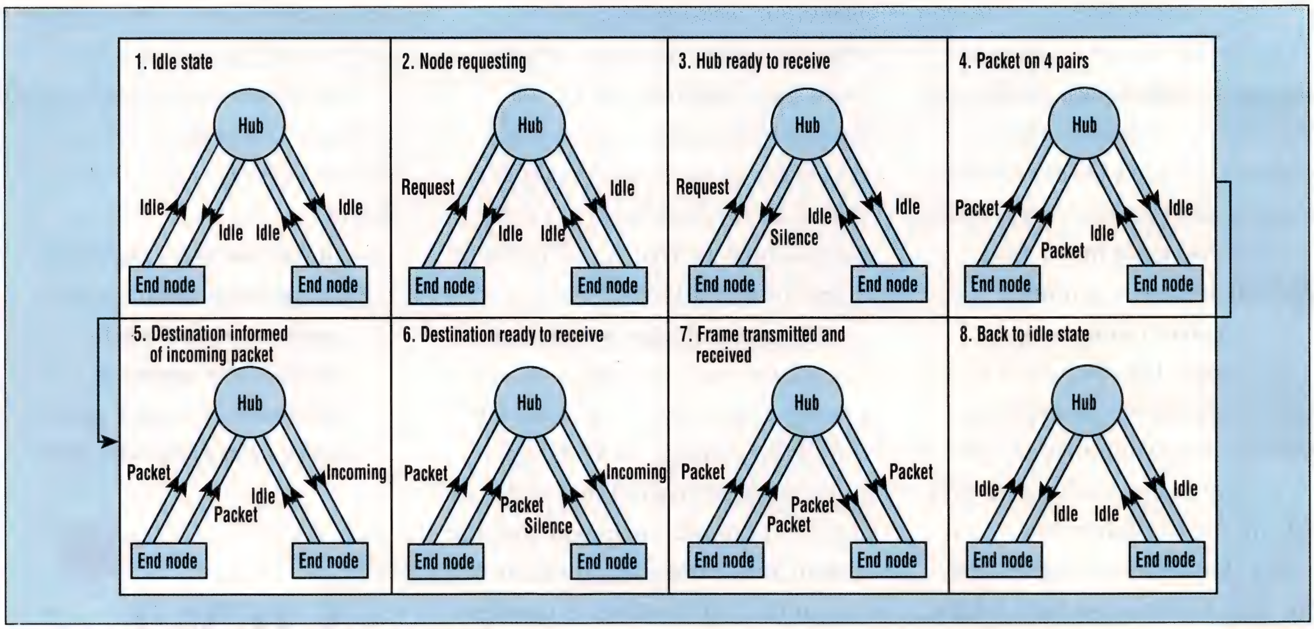
Tying the MAC and transceiver chips to a host-system bus, the T7383 DMA system-interface circuit connects directly to the EISA or ISA bus in a personal computer or server and controls all of the bus signals. The circuit also connects directly to the MAC chip and provides DMA support for data transfers to or from the host memory at rates exceeding 100 Mbits/s.

Putting the T7382 hub-controller IC and six transceiver chips on one small circuit board makes it possible to implement a six-port hub. The hub controller contains a 32-entry content-addressable memory (CAM) for addresses. The memory is used with the physical-layer transceiver interface to quickly match 48-bit destination addresses in the incoming packet with the local-port addresses. If a match occurs, the on-chip logic routes data to the local port. Additional logic includes a data serializer/deserializer, an encoder/decoder, a 5B/6B scrambler/descrambler, and circuitry for transmit/receive protocol control.

Multiple hub-controller chips can be locally connected through a parallel-port expansion bus so that a group of T7382s can function as a multi-hub repeater, with all of the T7382s interconnected through a common backplane. Furthermore, multiple hub controllers can also be hierarchically cascaded by using a dedicated up-link port and configuring one or more of the six ports as down-link ports.

GAINING ACCESS

When a node has to send a data packet, it waits for its turn in the round-robin transmission sequence. The system interface chip signals a request to transmit by first changing the state of the two transmit control lines from the idle state (00) to the transmit start (01). When the MAC gains access to the network for the right to transmit, it sends back a signal to the system interface chip by asserting the transmit "ready" signal. The MAC then locks onto the transmit-path bus, accepting the data packet from the system interface chip. After the last byte is received by the MAC chip, the system interface circuit changes the transmit control lines to 11, which signals the MAC circuit that the complete packet was transferred. Finally, the system interface returns the transmit control lines to their 00 idle state.



2. TO TRANSFER A DATA PACKET, **the idle end node first sends out a request to the hub. After the hub responds, the sending end node transmits the data packet. Next, the hub receives the packet and decodes it to determine the port address to which it must be sent. Once the address is matched, the packet is sent through to the receiving end node. After the packet transmission is completed, all nodes return to the idle state.**

What's the right way to conform to RS-232 standards in your 3.3-V designs?

TI's SN75LV4735. A complete serial port on a single chip.

From laptop to palmtop and beyond, Texas Instruments now brings you a single-chip serial port for 3.3-V systems. With full conformance to EIA-232, your battery-powered portable equipment will easily reach the next generation of compatible communication.

This low-voltage device integrates three drivers, five receivers and a charge pump, handling a range of peripherals with a single chip. A single chip that fully conforms to EIA-232 voltage levels.

Inherent in the 'LV4735 are key benefits of TI's LinBiCMOS™ technology. You'll find 6 kV of ESD protection, latchup immunity to 7 V on the logic inputs and the lowest available standby current, 10 µA.

SN75LV4735: The Reasons Why

- Full EIA-232-D compliance
- Built-in latchup immunity
- Lowest standby current: 10 µA
- 3 drivers/5 receivers; on-board charge pump
- 6-kV ESD protection
- 3.0- to 3.6-V operation
- 28-pin SSOP packaging

TI's flow-through architecture simplifies routing. It offers you a complete integrated solution in one 28-pin shrink small-outline package (SSOP). A solution that delivers up to 60-percent reduction in board size compared with standard SO packaging.

So if you're ready for a 3.3-V solution that will gear your design to longer battery life, just return the reply card. Or fax TI at **886-2-377-1460.** We'll send you a data sheet to get you on your way to the next generation of battery-powered designs.

EXTENDING YOUR REACH WITH TOTAL INTEGRATION™

TEXAS INSTRUMENTS

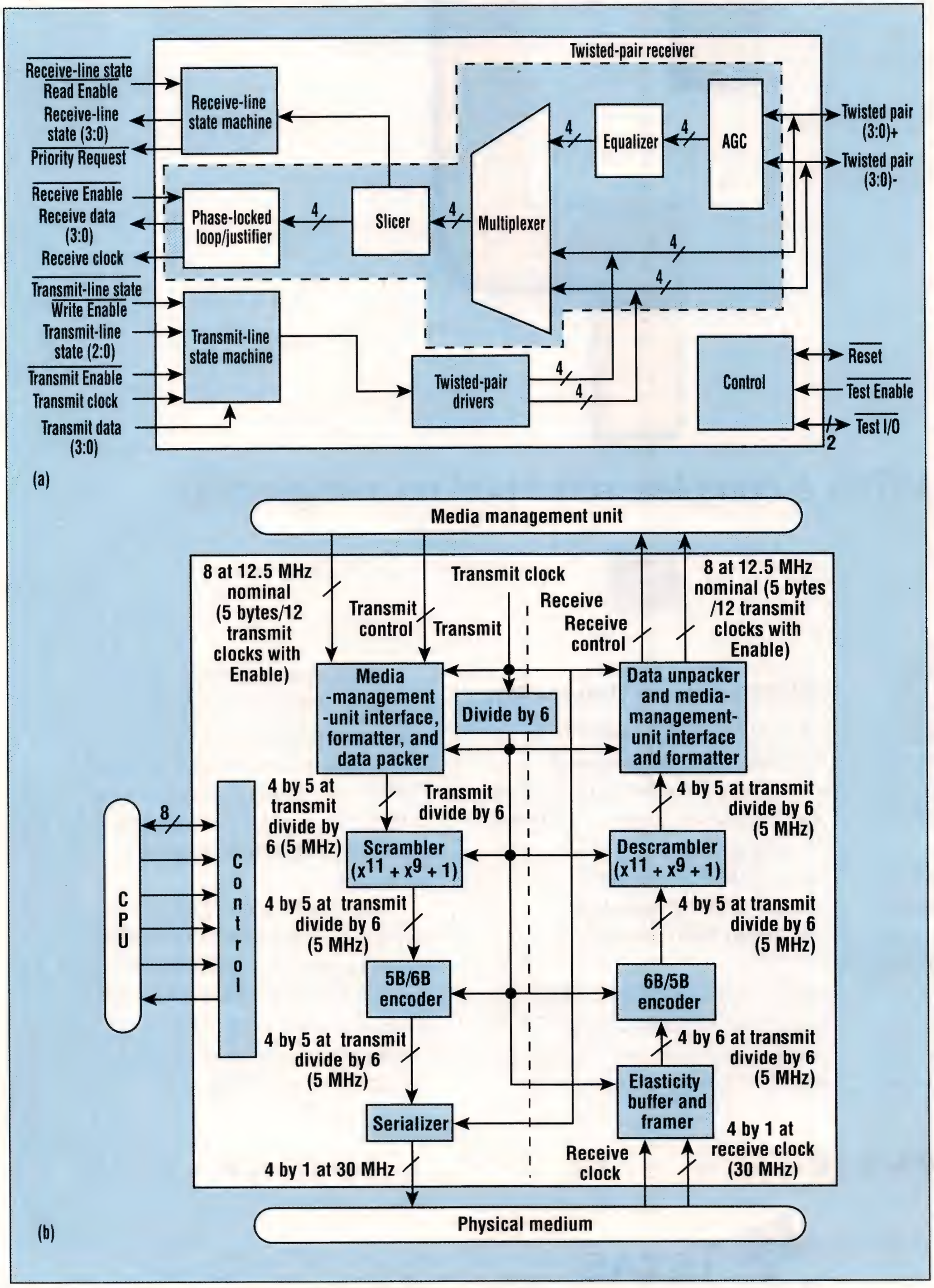
Australia & New Zealand: Sydney, 61-2-878-9000, fax 61-2-805-1186; Melbourne, 61-3-696-1211, fax 61-3-4446; Elizabeth, 61-8-255-2066, fax 61-8-255-2809. **Hong Kong:** 852-737-0338, fax 852-735-4954. **Korea:** 82-2-551-2800, fax 82-2-551-2828. **Malaysia:** 60-3-230-6001, fax 60-3-230-6605. **People's Republic of China:** 86-1-500-2255, ext. 3750, fax 86-1-500-2705. **Philippines:** 63-2-817-6031, fax 63-2-817-6096. **Singapore (& India, Indonesia, Thailand):** 65-350-8100, fax 65-253-6655. **Taiwan:** 886-2-713-9311, fax 886-2-716-9487.

© 1993 TI
™ Trademark of Texas Instruments Incorporated

00-840

The MAC chip performs the handshake sequence with the network to gain the right to transmit or receive data. When a transmit request is initiated, the circuit first constructs the four-stream frame from the data supplied by the system interface chip, adding the preamble and start-of-frame delimiters.

Furthermore, using information passed on by the system interface chip, the MAC in the Ethernet mode appends a packet assembly/disassembly (pad) if the MAC information field isn't long enough to ensure that the transmitted frame length is greater than or equal to 64 bytes. Also prepended to the data are the destination and source address fields, a length-count field, and a frame-check sequence to provide error detection and end delimiters. Consequently, the entire frame includes a 6-byte destination address, a 6-byte sender address, a 2-byte length field, a 46-to-1500-byte data/pad field, and a 4-byte frame-check sequence.


Twisted-pair receiver
Receive-line state Read Enable
Receive-line state (3:0)
Priority Request
Receive Enable
Receive data (3:0)
Receive clock
Transmit-line state Write Enable
Transmit-line state (2:0)
Transmit Enable
Transmit clock
Transmit data (3:0)
Receive-line state machine
Phase-locked loop/justifier
Slicer
Multiplexer
Equalizer
AGC
4
Twisted pair (3:0)+
Twisted pair (3:0)-
Transmit-line state machine
Twisted-pair drivers
Control
Reset
Test Enable
Test I/O
2
(a)
Media management unit
8 at 12.5 MHz nominal (5 bytes/12 transmit clocks with Enable)
Transmit control
Transmit
Transmit clock
Receive
Receive control
Media -management -unit interface, formatter, and data packer
Divide by 6
Data unpacker and media-management-unit interface and formatter
8
CPU
Control
4 by 5 at transmit divide by 6 (5 MHz)
Transmit divide by 6
Scrambler (x11 + x9 + 1)
Descrambler (x11 + x9 + 1)
5B/6B encoder
6B/5B encoder
4 by 6 at transmit divide by 6 (5 MHz)
Elasticity buffer and framer
Serializer
4 by 1 at 30 MHz
Receive clock
4 by 1 at receive clock (30 MHz)
Physical medium
(b)

3. CONTAINING FOUR TWISTED-PAIR transceivers on one chip, the T7380 provides the physical interface to the network (a). Each transceiver channel includes an adaptive equalizer, AGC, timing recovery phase-locked loops, data-justification logic, and a diagnostic loopback for system testing. The media-access controller (MAC) formats/unformats, scrambles/descrambles, encodes/decodes, and serializes/deserializes the data (b).

When an end-node communicates with a hub, the sequence of operations involves a simple eight-step process that starts and ends with the end nodes in an idle state *(Fig. 2)*. A packet transmission request is then put on the network and sent to the hub. That request can be either a normal or a high-priority type. Normal-priority traffic is intended for non-real-time data transfers, while high-priority traffic is expected to carry multimedia information or handle real-time control.

Until the request is acknowledged, the MAC won't transmit, but it can still receive any incoming frames. However, once the request is acknowledged, the MAC sends four simultaneous serial bit streams to the transceiver chip, which places the data onto the physical network. At the same time, the hub examines the incoming data to determine the destination address and establish a link with the desired destination end node. After the link to the receiving end node is established, the hub just routes the incoming data to the destination node over the four UTPs. When the transmission ends, the MAC notifies the system interface chip and then awaits the next request.

When the MAC or repeater chips are first initialized,

A/D Family.

Next Industry Standard

Our new family of 12- and 16-bit pin-compatible CMOS A/Ds deliver exceptional value without performance compromises. This innovative family includes: *ADS7804* & *ADS7805*—100kHz, 100mW, (12-, 16-bit) along with *ADS7806* & ADS780*7*—40kHz, 35mW, (12-, 16-bits) and our newest, fastest *ADS7810* (12-bit)—sampling at 800kHz! With their unmatched combination of performance, low cost, completeness, ease-of-use, and cross-compatibility, the *ADS Family* is destined to be the next industry standard.

Tomorrow's Innovations

We designed our new family with the future in mind. These complete A/Ds include standard input ranges, input overvoltage protection, low power CMOS construction, common control logic, and maximum pin compatibility—perfect for today and tomorrow! You'll be designing-in this family for years—even into the 21st century! And, with prices much lower than the "competition", this family delivers more for less. Performance options plus low pricing make this innovative, pin-compatible *ADS Family*—***Bit for bit, the best A/Ds ever!***

BURR - BROWN®

Burr-Brown Corporation • Corporate Headquarters • P.O. Box 11400 • Tucson, AZ 85734 USA

International Subsidiary Offices: Austria (43) 222 62 63 71, **France** (33) 1 395 43558, **Germany** (49) 711 77040, **Italy** (39) 2 580 10504, **Japan** (81) 33 586 8141, **Netherlands** (31) 03465 50204, **Switzerland** (41) 1 7240928, **United Kingdom** (44) 923 233837.

CIRCLE 220 FOR U.S. RESPONSE CIRCLE 221 FOR RESPONSE OUTSIDE THE U.S.

Easy.

Complete and Accurate

ADS7804 & ADS7805 are the latest additions to our growing family of sampling A/Ds. Providing 12 and 16 bits of resolution at 100kHz, both are pin-compatible and complete with sample/hold, precision reference, clock, and parallel three-state output drivers on the chip, all packaged in compact, 28-pin 0.3" plastic DIPs or SOICs. They're the first monolithic, CMOS sampling A/Ds in the world with performance guaranteed to Nyquist.

Simple to Design In

ADS7804 & ADS7805 are easy to use! Both drop into most applications and work the first time, use minimal power, and operate from a single +5V supply. Withstanding input overvoltages to ±25V, they simplify or eliminate the need for input protection. And, both are easily driven by almost any op amp. They accept ±10V inputs and have "no missing codes" over their extended –40/+85°C industrial temp range. Both sample at 100kHz (min), while dissipating only 100mW (max). And, our pricing is easy—very easy—on your budget. Make your next design your easiest with ADS7804 & ADS7805!

Bit for bit, the best A/Ds ever!

BURR - BROWN®

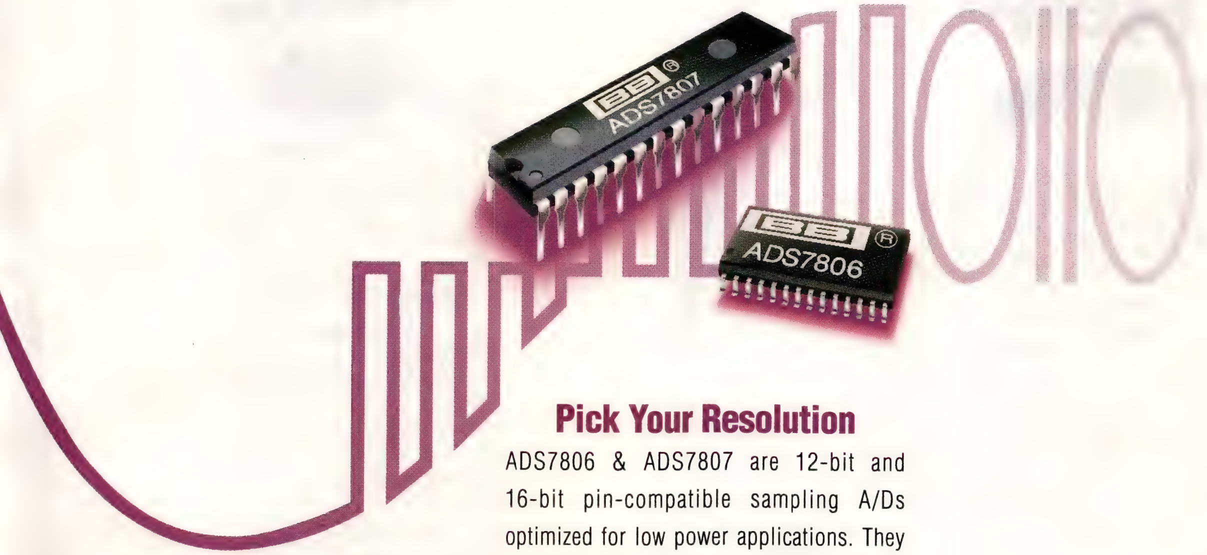
BB

Burr-Brown Corporation • Corporate Headquarters • P.O. Box 11400 • Tucson, AZ 85734 USA

International Subsidiary Offices: Austria (43) 222 62 63 71, **France** (33) 1 395 43558, **Germany** (49) 711 77040, **Italy** (39) 2 580 10504, **Japan** (81) 33 586 8141, **Netherlands** (31) 03465 50204, **Switzerland** (41) 1 7240928, **United Kingdom** (44) 923 233837.

CIRCLE 254 FOR U.S. RESPONSE **CIRCLE 255 FOR RESPONSE OUTSIDE THE U.S.**

Low Power.



Pick Your Resolution

ADS7806 & ADS7807 are 12-bit and 16-bit pin-compatible sampling A/Ds optimized for low power applications. They sample at 40kHz and consume less than 35mW from a +5V supply. In the stand-by mode, they consume only 50μW. Both exceed "574s" accuracy, but use only 10% of their power. And, data is available in parallel 8–bit bytes or flexible serial modes. ADS7806 & ADS7807 are complete A/Ds including a reference—a first for low power converters. Precision resistors provide input ranges of ±10V and 0V to 5V, plus 0V to 4V for complete systems using only a 5V supply. ADS7807 has "no missing codes" over temperature at 16-bits; ADS7806 at 12-bits. Available in 28-pin 0.3" plastic DIPs and SOICs, both are specified over the industrial temperature range of –40/+85°C.

Low Prices, too!

ADS7806 & ADS7807's low power, accuracy, high resolution, and *low price* just can't be beat! ADS7806 delivers more performance for its price, while ADS7807 is priced 30% lower than those "other A/Ds". For your next design, use the best for less. ADS7806 & ADS7807 are ***Bit for bit, the best A/Ds ever!***

BURR - BROWN®

Burr-Brown Corporation • Corporate Headquarters • P.O. Box 11400 • Tucson, AZ 85734 USA

International Subsidiary Offices: Austria (43) 222 62 63 71, **France** (33) 1 395 43558, **Germany** (49) 711 77040, **Italy** (39) 2 580 10504, **Japan** (81) 33 586 8141, **Netherlands** (31) 03465 50204, **Switzerland** (41) 1 7240928, **United Kingdom** (44) 923 233837.

CIRCLE 256 FOR U.S. RESPONSE **CIRCLE 257 FOR RESPONSE OUTSIDE THE U.S.**

Solutions.

Help.

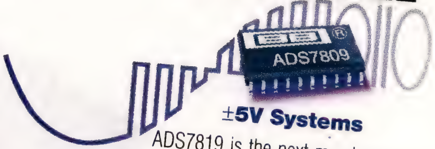
FREE Samples

Try the best A/Ds ever—FREE! Just FAX **1-602-741-3895** for samples, data sheets, applications info—whatever you need to make your next design the best!

Support

Need applications support? Need analog assistance? Need the best A/Ds ever? For all your analog answers, please FAX 1-602-741-3895! For complete support our *ADS Family* is—

Next.



±5V Systems

ADS7819 is the next member of our growing *ADS Family*. Available in Q4, it's a complete, 12-bit, 800kHz A/D with a ±2.5V input range—perfect for ±5V supply systems. It's pin-compatible with our ADS7810.

Small Size

Also available in Q4 are our smallest sampling A/Ds ever! ADS7808 & ADS7809 are 12- and 16-bit, 100kHz, complete A/Ds with serial output—all in space saving 20-pin packages. Remember, you'll be designing in the *ADS Family* for years—even into the 21st century.

Bit for bit, the best A/Ds ever!

Fast.

800kHz Sampling

ADS7810 is our fastest 12-bit A/D yet! The newest member of our innovative *ADS Family* is complete with clock, sample/hold, internal reference, parallel microprocessor interface, and three-state output drivers.

World's Fastest

ADS7810's 800kHz sampling rate is guaranteed over the extended industrial temperature range of –40°C/+85°C making it the world's fastest 12-bit, monolithic SAR ever—60% faster than its closest rival! And, it's the easiest A/D to use in this performance range. Available in 28-pin plastic DIPs, SOICs, and in die form. Remember, ADS7810 is the fastest member of this growing *ADS Family*.

Bit for bit, the best A/Ds ever!

BURR-BROWN®

Options.

Performance Choices

Chose the best sampling A/D for your application from the widest variety of performance options. You select what's most important—

Speed:

800kHz, 12-bits—*ADS7810*
100kHz, 12-bits—*ADS7804*
100kHz, 16-bits—*ADS7805*

Power:

35mW, 12-bits—*ADS7806*
35mW, 16-bits—*ADS7807*
100mW, 12-bits—*ADS7804*
100mW, 16-bits—*ADS7805*
250mW, 12-bits—*ADS7810*

Resolution:

12-bits—*ADS7806* (40kHz)
12-bits—*ADS7804* (100kHz)
12-bits—*ADS7810* (800kHz)
16-bits—*ADS7807* (40kHz)
16-bits—*ADS7805* (100kHz)

Serial Output:

ADS7806—ADS7807

Parallel Output:

ADS7804—ADS7805
ADS7806—ADS7807
ADS7810

With all these options, the *ADS Family* has

Bit for bit, the best A/Ds ever!

BURR-BROWN®

BURR - BROWN®

Burr-Brown Corporation • Corporate Headquarters • P.O. Box 11400 • Tucson, AZ 85734 USA

International Subsidiary Offices: Austria (43) 222 62 63 71, **France** (33) 1 395 43558, **Germany** (49) 711 77040, **Italy** (39) 2 580 10504, **Japan** (81) 33 586 8141, **Netherlands** (31) 03465 50204, **Switzerland** (41) 1 7240928, **United Kingdom** (44) 923 233837.

CIRCLE 258 FOR U.S. RESPONSE

CIRCLE 259 FOR RESPONSE OUTSIDE THE U.S.

A PRIMER ON QUARTET SIGNALING

Employing a "divide and conquer" approach, quartet signaling delivers data at 100 Mbits/s. However, quartet signaling is unlike other serial data approaches that try to put all of the data over a single twisted pair. Rather, it divides the data into four parallel data streams and transmits all four streams simultaneously over four pairs of unshielded twisted-pair copper wires. As a result, each of the four streams has a data rate of only 30 MHz (after encoding). This improves the distance over which the signals can be transmitted, and makes for simpler transmit and receive circuits.

In quartet signaling, data is scrambled, encoded, and then transmitted. The 20-bit data words are first divided into four 5-bit groups which are encoded into four 6-bit groups (5B/6B encoding) using non-return-to-zero coding. Next, one bit from each 6-bit group is fed into a serializer that delivers a 1-bit-wide data stream of 24 bits for each 20-bit block fed into the scrambler.Scrambling and encoding give the data some resilience against errors and noise, providing a more uniform spectrum, RF emissions and easing clock recovery.

The 5B/6B encoding and decoding maintains a dc balance in the data stream by turning 5-bit quintets into 6-bit symbols. That results in 20 symbols out of 32 being balanced. By looking at all combinations of the 6 bits in each symbol, 20 symbols have the same number of 1s and 0s (resulting in more-even energy content). Unbalanced words must alternate between words with one too many zeros (weight 2) and one too many ones (weight 4). If, during reception, a station or repeater gets two of the same type of unbalanced words in a row, the receiver knows a transmission error has occurred and will ask for a retransmission of the data.

Two of the four bits transmitted in parallel are ahead of the other two bits by three bit spaces. That delay aids in detecting a single-bit error. By delaying the other two bits, the data transmission is more immune to error bursts of up to seven bit-periods, thus adding more resiliency to the transmission scheme.

---

training sequences are implemented between the end node and the hub. During training, the adaptive equalizers at each end of the link learn the characteristics of the link and adjust themselves to ensure minimal errors during data transmission. Training frames must be at least 640 bytes long. In total, 25 or more packets must be transmitted to ensure completion of the equalization process. During training, the hub learns the end node's address. Training will take place as long as the contents of the training-frame counter are nonzero. Each training packet transmitted reduces the register count by one. When the count equals zero, training is finished.

As a result, thanks to the adaptive equalization included in the transceiver chips, the bit error rate at 100 Mbits/s is less than or equal to that of 10Base-T 10-Mbit/s networks. Each of the four receive channels includes a phase-locked loop, the adaptive equalizer, automatic gain control, a data justifier, and energy-detection circuits *(Fig. 3a)*. The data justifier compensates for phase differences between the four channels and aligns them to a single recovered clock. The chip also performs the transmit- and receive-tone generation—transmit tones from the MAC/hub are encoded and transmitted on twisted pairs 2 and 3; receive tones are decoded from twisted pairs 0 and 1 and then sent to the MAC/hub.

The MAC circuit performs all of the packet (frame) assembly and disassembly for the transmit and receive functions *(Fig. 3b)*. Data streams sent to it by the system interface circuit are formatted, sliced, scrambled, encoded and then serialized into four parallel data streams. On the receive side, the reverse takes place—data streams are captured in a buffer, returned to bit-parallel form, decoded, descrambled, and unpacked, ready to be sent to the system interface controller over an 8-bit synchronous bus. A separate 8-bit asynchronous microprocessor interface on the chip allows for local station management to be done as well. Network management support in the form of frame and error counters, and loopback diagnostics, are also included on the MAC.

The DMA system-interface-controller chip buffers the transmitted or received information in its own internal 2-kword-by-8-bit transmit and receive buffers, eliminating the need for off-chip memory in cost-sensitive applications. The internal shared-buffer management and scatter/gather capability makes the interface circuit very efficient. Also, the high-performance EISA-bus host interface provides a 32-bit multiplexed address and data path to the host system with byte parity.

The interface supports bus mastering as well as big- and little-endian byte ordering, and allows programmable-length (up to 64 bytes) burst data transfers at rates of at least 25 MHz. The circuit also can be set up to connect to lower-performance 16-bit ISA buses. Local intelligence can be added to the system interface controller by using the node-processor interface port—a 16-bit bidirectional data bus with parity that sets up the initial configuration and supports interrupt clustering.

The hub controller chip helps simplify the design of managed hubs: It contains most of the control logic needed to oversee six 100Base-VG ports and one up-link port. The chip shares its receiver and transmitter sections among all ports. Its receive and transmit architecture is very similar to the MAC—the transceiver chip sends the packet while the hub chip recognizes the serial frame data and performs the 5B/6B decoding and data descrambling. The hub controller chip then performs the data address matching in its CAM. Finally, when a match occurs, it forwards

Such simplicity and breadth!

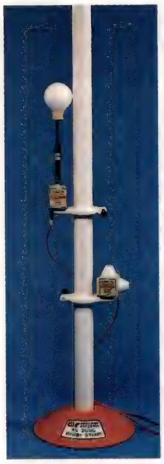
With this one compact system, you enjoy complete E-field monitoring capability up to 40 GHz, for fields from one to 300 volts per meter.

Inside your shielded room: A probe with frequency response from 10 kHz to 1 GHz (enough bandwidth for 82% of susceptibility-test applications); and another probe with a range from 80 MHz to 40 GHz. Both probes have rechargeable batteries for operation up to 40 hours.

Outside the shielded room, connected through glass fiberoptic cables that can carry signals as far as 1,000 meters, is the remarkable new FM2000 monitor — offering you total flexibility for measuring and leveling fields around the EUT.

The FM2000 accommodates up to four probes of either or both frequency ranges, for placement at various locations in the shielded room. Each probe delivers its own signals through an input card to the control console, and you can select HI/LO/AVG readings from multiple probes at the touch of a finger on the keypad. Outputs are provided to IEEE-488 and RS-232 interfaces and 0-4 Vdc, giving you the widest choice for automatic field control — plus audible signal and SPDT contact closure for excessive-field-level or low-battery alarm.

With European and American immunity requirements increasing daily, you need a reliable ultra-broadband field-monitoring system, available from stock now, for your susceptibility testing. Get all the technical data you need on the FM2000 system. One of our applications engineers will pick up the phone himself when you call, toll-free, **1-800-933-8181.**



84-inch probe stand (easily cut to lower height) lets you position probes where you want them. One screw clamp included with each stand, additional clamps available.

ar AMPLIFIER RESEARCH

**160 School House Road
Souderton, PA 18964-9990 USA
Phone 215-723-8181. Fax 215-723-5688**

For engineering assistance, sales, and service throughout Europe, call EMV:
Munich, 089-612-8054; London, 0908-566556; Paris, 1-64-61-63-29

6313

Circle 86

CHIP SET MOVES 100 MBITS/S TO THE DESKTOP

the packet to the transmitter, which rescrambles and encodes the data, adds the preambles, and then sends the data to the port with the matching address.

The hub controller can support multicast or broadcast modes. In the multicast mode, it will support bundles or no bundles. With bundles, some of the six connected ports can be in the same bundle; with no bundles, none of the six connected ports are in the same bundle. The address CAM contains 12 entries—one for each port and six multicast groups, with each entry consisting of a 48-bit address.

Designing systems around the chip set will be easy because the chips require minimal glue logic or support components—some LEDs, a 30-MHz oscillator, isolation transformers, a control microprocessor/microcontroller, some RJ-45 connectors, and various passive components. AT&T also developed several evaluation cards, including an EISA/ISA hub controller card and individual station cards that provide end-node interfaces. An evaluation kit containing the hub card and three station cards, along with station-management software, network-management software, and all technical documentation, is also available. The network software enables designers to set up and exercise the network in accordance with the standard, and to override normal network operation for extensive chip-level testing (continuous data, illegal conditions, etc.).☐

PRICE AND AVAILABILITY

The T7380, 7381, 7382, and 7383 chips for 100Base-VG systems will be available in sample quantities later this quarter, with production expected in the second quarter. The three-chip set used on the node adapters (T7380, 81, and 83) will range in price from $50 to $80 in volume, depending on the system interface. A set of chips for a six-port hub (6 T7380s and one 82) will sell for between $175 and $250 in volume. The evaluation kit will go for between $3000 and $5000.

AT&T Microelectronics, 555 Union Blvd., Allentown, PA 18103; John Bestel, (215) 439-5130, ext. 256. **CIRCLE 515**

HOW VALUABLE?	CIRCLE
HIGHLY	530
MODERATELY	531
SLIGHTLY	532

1994 TECHNOLOGY FORECAST

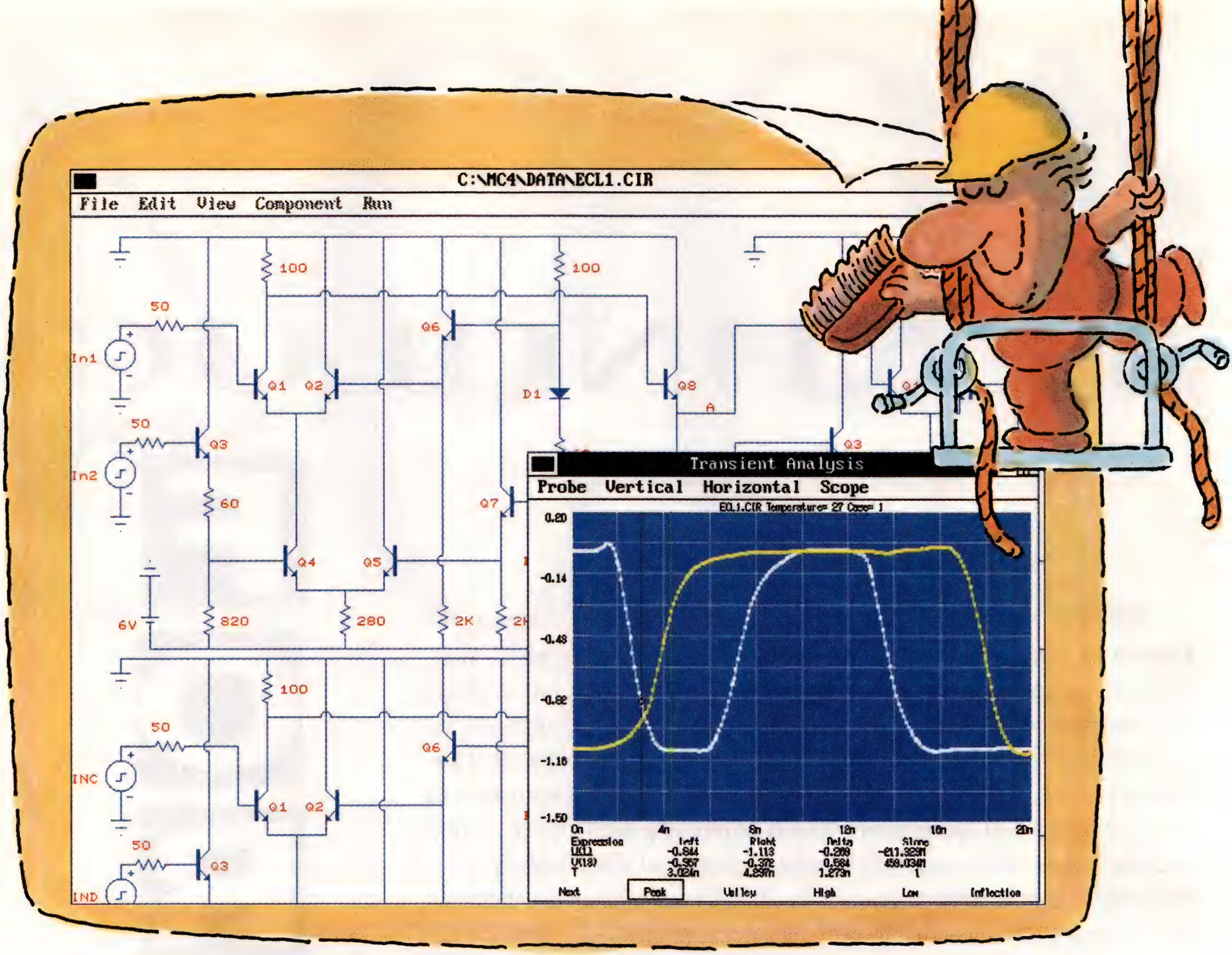
Forecasting certainly isn't an exact science. Nevertheless, for our readers—engineers and engineering managers—to stay on the leading edge, they must always stay abreast of current and future trends. Usually, the right design decisions are made by those engineers who keep one eye on the infusion of advances that disseminate into the electronics world. This year, as *Electronic Design* has done in its first issue every year, we've chosen to look at breaking developments in four enabling sectors: *digital process technology, analog and mixed-signal process technologies, electronic design automation,* and *software development*. These four Special Reports are supported by eight interviews with industry experts in key electronics areas.

In *digital process technology*, the trend is toward systems on a chip. CMOS processes lead the way with 0.4-μm minimum feature sizes and line widths going down to a mere 0.1 μm. Such tiny sizes will lead to multimillion-gate ASICs, forcing semiconductor vendors to create their own standard-applications solutions. Interconnection technologies will also play an important role, making possible the anticipated high levels of integration.

In the *analog and mixed-signal* sector, silicon-germanium (SiGe) and silicon-on-insulator (SOI) processes will head the field. SiGe processes will make possible transistors with f_ts of over 100 GHz. And SOI will be the driving force behind the ultimate analog and mixed-signal processes, namely complementary bipolar CMOS.

In *electronic-design automation*, the challenge will be to merge vast amounts of tools and data into a unified environment. With productivity as the key to design success, it's no longer enough for engineers to only master point tools. They must also be adept in the nuances of team-based approaches that utilize multiple methodologies.

In *software development*, software engineers will face many of the same obstacles that are now hampering hardware designers, namely shorter time-to-market, higher quality, and lower costs. Thus, software designers must work smarter, which means writing software in modular form so that it can be reused in more than one project. This will induce a migration to C++, a language whose object-orientation lends itself well to modularity and code reuse.



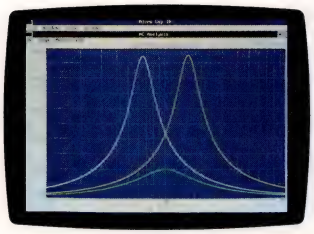
```
Expression      Left      Right     Delta      Slope
V(1)          -0.844     -1.113    -0.269  -211.329M
V(18)         -0.567     -0.372     0.584   458.034M
T             3.024n     4.297n    1.273n          1
```

INTRODUCING MICRO-CAP IV.™ MORE SPICE. MORE SPEED. MORE CIRCUIT.

PC-based circuit analysis just became faster. More powerful. And a lot easier. Because MICRO-CAP IV is here. And it continues a 12-year tradition of setting CAE price/performance standards.

Put our 386/486 MICRO-CAP IV to work, and you'll quickly streamline circuit creation, simulation and edit-simulate cycles — on circuits as large as 10,000 nodes. In fact, even our 286 version delivers a quantum leap upward in speed. Because, for one thing, MICRO-CAP IV ends SPICE-file-related slowdowns; it reads, writes and analyzes SPICE text files and MC4 schematic files. It also features fully integrated schematic and text editors. Plus an interactive graphical interface — windows, pull-down menus, mouse support, on-line HELP and documentation — that boosts speed even higher.

Now sample MICRO-CAP IV power. It comes, for example, from SPICE 2G.6 models plus extensions. Comprehensive analog behavioral modeling capabilities. A massive model library. Instant feedback plotting from real-time waveform displays. Direct schematic waveform probing. Support for both Super and Extended VGA.



AC Analysis

And the best is still less. At $2495, MICRO-CAP outperforms comparable PC-based analog simulators — even those $5000+ packages — with power to spare. Further, it's available for Macintosh as well as for IBM PCs. Write or call for a brochure and demo disk. And experience firsthand added SPICE and higher speed — on larger circuits.

spectrum
1021 S. Wolfe Road
Sunnyvale, CA 94086
(408) 738-4387 FAX (408) 738-4702

CIRCLE 232 FOR U.S. RESPONSE

CIRCLE 233 FOR RESPONSE OUTSIDE THE U.S.

BY DAVE BURSKY

MILLION-GATE ASICs TO PROVIDE SYSTEMS ON-A-CHIP

The demand for higher IC performance and increased functionality continues unabated, with silicon manufacturers pushing their fabrication processes to new levels of integration. Today's 0.5-μm processes will soon give way to processes with design rules of about 0.4 μm. As demonstrated at last month's International Electron Devices Meeting in Washington, D.C., CMOS processes with minimum features as small as 0.1 μm are possible. Such processes are expected to be ready for use by the turn of the century *(Fig. 1a)*.

Advances in circuit design and integration have already pushed the gate count in CMOS circuits to well over the 1 million mark, giving system designers the ability to implement major system functions on a single monolithic chip. However, systems are also getting more complex as the functions designers want to implement demand computational power on a chip that even mainframe computers a decade ago couldn't deliver.

COMPLEX SYSTEMS ARE DEMANDING CUSTOM OR ASIC SOLUTIONS

As circuit designs get more complex, though, fewer and fewer standard applications can take advantage of such high levels of integration. The only exceptions are microprocessor and memory chips. Many companies are thus turning to high-density gate arrays and standard-cell design libraries to create their own solutions. The high-density gate arrays and sub-micron cell libraries are therefore playing an evermore important role as designers try to perform the magic of squeezing 10 lbs. of system into a 5-lb. container.

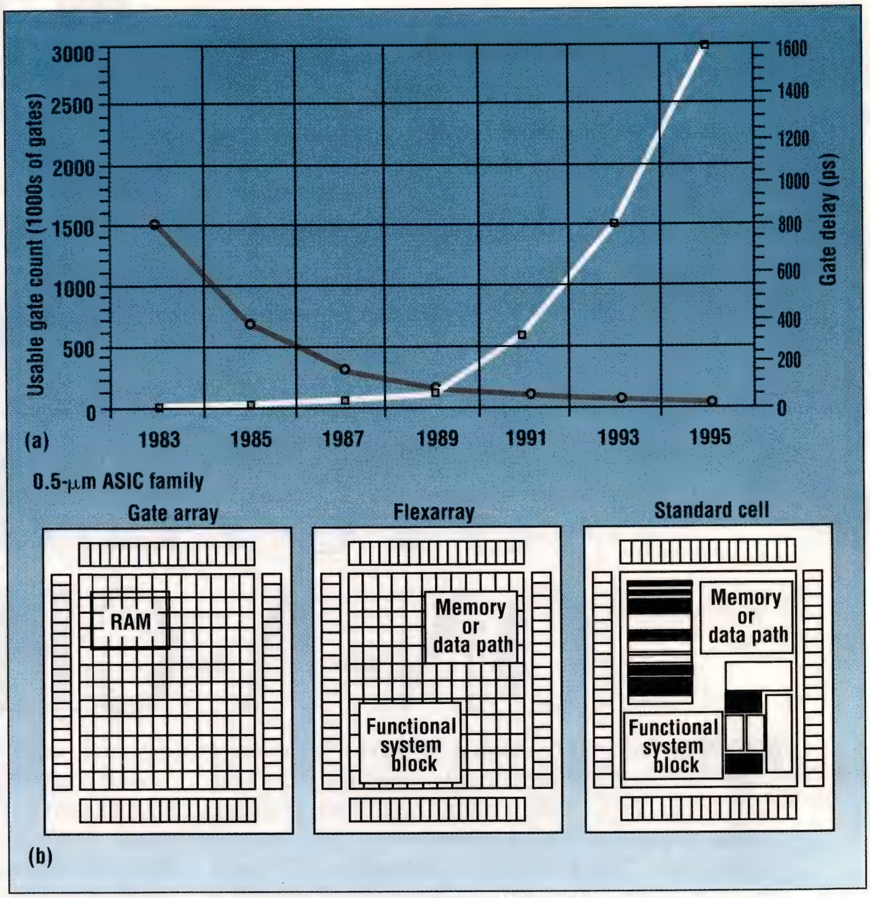
Of course, getting small feature sizes isn't the only factor necessary to implement circuits with small dimensions. Interconnection technologies must also advance, from the typical three levels of metal used today to four, five, or even more levels to achieve the high gate utilizations needed to justify the use of such complex chips.

For example, if only three levels of metal are used to interconnect gates on a base chip that has, say, 500,000 gates, there's a good possibility that about half the gates would be forced to remain unused, due to routing limitations. If a fourth level of metal is added, the percentage of unused gates probably decreases to about 30%, while a fifth level of metal could decrease the percentage of unused gates to about 15%.

Thus, routing capability plays a very important role in determining the actual number of usable gates on a chip. The obvious result is that if more gates are usable, the designer can implement a more-complex function on the silicon, possibly eliminating the need to partition a design across multiple chips. The not-so-obvious result is the performance gained by keeping all the circuitry on one chip, avoiding the I/O delays and loading effects encountered when moving signals from chip to chip.

Cell libraries also play a major role in distinguishing one vendor's capabilities from another's. With multiple suppliers offering chip complexities of half-a-million or more gates, the key to a design win is no longer a game of who has the most gates. According to Frank Ramsay, director of strategic marketing at Toshiba America Electronic Components, gate count isn't the "test of manhood" it once was. Rather, the vendor selection process could boil down to which supplier has the best choice of available I/O cells, megafunctions, and specialized blocks, such as one-time programmable cells or mixed-signal capabilities.

ASICs, of course, come in all sizes and combinations of features, but can typically be categorized into three structural groups. These include standard sea-of-gates arrays, embedded arrays—which combine one or more dedicated blocks of memory or logic and the remaining area is filled in with gates—and full standard-cell-based chips that combine multiple megafunction blocks, memory blocks, and glue logic *(Fig. 1b)*. The structural choice depends on such factors as time-to-market, desired performance level, and area and cost tradeoffs. This choice lets designers optimize their system design by combining one or more approaches.



1. Using its gate-array families as a rough guide, this graph from LSI Logic shows past, present, and future ASIC density and propagation-delay progress (a). According to VLSI Technology, ASIC options typically include three basic chip architectures (b): a standard sea-of-gates (SOG) array (left), an SOG array combined with a limited number of fixed, prediffused blocks such as memory—like VLSI's Flexarrays—(middle), and a full standard-cell-based chip (right). The structure used depends on cost, time-to-market, and performance tradeoffs.

To entice the designer to select their respective approach, each ASIC supplier has come up with a mix of cells or megafunctions to suit particular industry segments. For example, VLSI Technology has crafted many of its complex functions to support communications and portable computing applications. Designers at NEC, on the other hand, are targeting consumer and portable computing systems, such as personal digital assistants. Other companies, such as IBM and LSI Logic, have their eyes on high-end systems, such as large computers or workstations or signal-processing subsystems. Still other companies have broad focuses that encompass some of the same areas, as well as areas not directly focused on by the other ASIC suppliers.

Although large megacells are common (such as multipliers, blocks of static RAM, interrupt controllers, and so forth), advanced functions, such as CISC or RISC microprocessor cores, major digital-signal-processing (DSP) functions, data-encryption circuits, or data-compression blocks are just starting to become available. One-time programmable elements, long the domain of field-programmable gate arrays, are making some headway into standard-cell-based ASICs, too.

VLSI Technology, for example, has started incorporating the antifuse technology it licensed from QuickLogic to provide ASIC customers with a limited amount of last-minute field configurability. Initially used to hold a few configuration bits for a serial number or some other simple information, the concept can readily be extended to control-circuit configurations, or as in FPGAs, define some custom logic. RISC and CISC processor cores, such as the ARM offered by VLSI Technology, the R3000 offered by LSI Logic, and the V30MX from NEC Electronics, also give designers a way to differentiate their products by embedding a significant amount of intelligence that can compute and control any desired system.

Early last year, S-MOS Systems unveiled an easy-to-use library of complex megacells using a configurable application-specific product design methodology that points the way to how future megacells may be designed. The methodology is based around very malleable megafunctions—designers can quickly remove pieces from or add sections to a megafunction. That would let designers tune the

PCMCIA FAX MODEM THE SMART WAY

Fax/Modem cards are not all created equal. SMART Fax/Modem cards are, in fact, a much smarter investment than the rest. Here's why:

- They're compatible with all major notebooks, palmtops and PDAs with with PCMCIA Type II slots.
- In sleep mode, our cards use less battery power than any other Fax/Modem card in the industry.
- Our built-in phone line interface means there are no bulky add-ons to deal with, and no flimsy pop-out connectors to break off.
- Flash Memory technology makes the ST 1414 easy to upgrade. So you protect your investment by adding new features as they become available.
- The ST 1414 features accelerated throughput under Windows.™
- Our software is simple to use yet powerful.
- SMART's European version is certified for legal use in most Western European countries.

Add our rugged construction, fast, friendly tech support and comprehensive warranty and you've got the best possible PCMCIA Fax/Modem card investment. That's Fax/Modem the SMART way.

ST 9624
Data 2400 bps
Fax 9600 bps send
4800 bps receive

ST 9624E
ita 2400 bps
ax 9600 bps

ST 1414
Data 14.4K bps
Fax 14.4K bps

CIRCLE 230 FOR U.S. RESPONSE

CIRCLE 231 FOR RESPONSE OUTSIDE THE U.S.

For more information, contact:

SMART
Modular Technologies

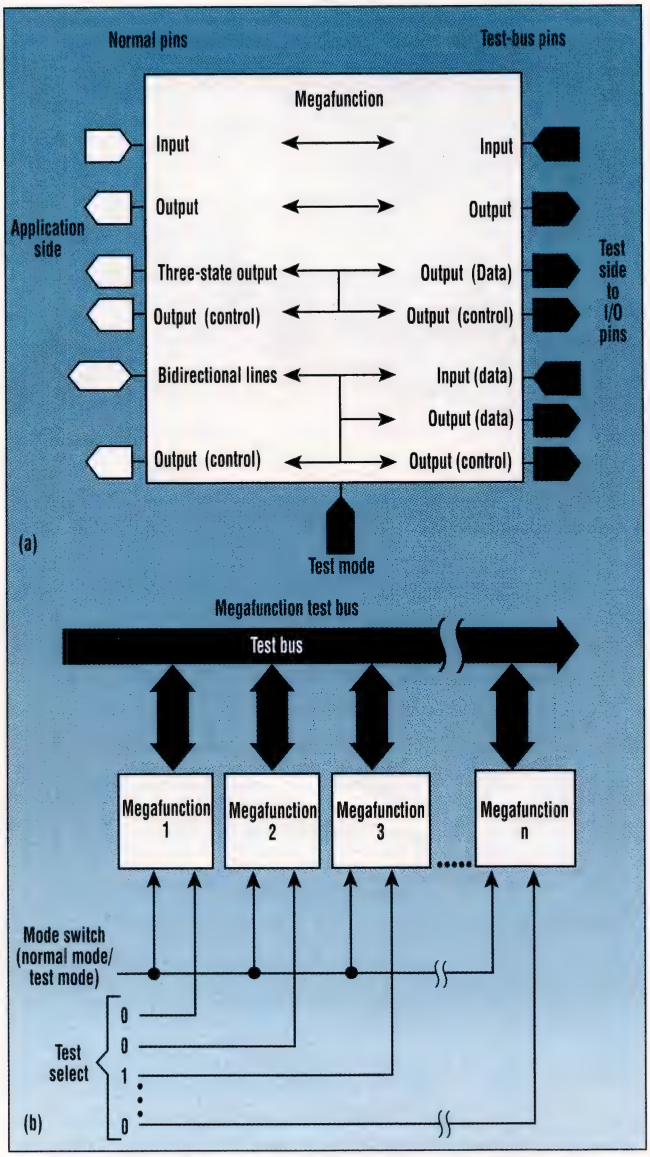
45531 Northport Loop West, Fremont, California 94538.
Telephone: 510.623.1231, ext. 101. Fax: 510.623.1434.
Toll Free: 1.800.536.1231.

© 1993 SMART Modular Technologies. SMART and the SMART logo are trademarks of SMART Modular Technologies.

function to a particular system and thus further optimize the blocks to the application. By permitting the designer to tune the megafunctions, the chip can be either cost-reduced by deleting unwanted and unneeded functions, or souped-up by added performance-accelerating features (ELECTRONIC DESIGN, *Feb. 4, p. 92).*

NEEDED: ON-CHIP TESTABILITY

Furthermore, the complexity of large chips requires that some type of on-chip testability features be included. Most suppliers have already implemented some form of the joint testability access group (JTAG) test port and test controller on their chips. However, for an even-more complete test capability, a few array suppliers—Oki Semiconductor and VLSI Technology to name just two—have included the CrossCheck test scheme as part of some base arrays, making circuits implemented on those arrays 100% testable.



2. This ASIC test scheme from NEC employs an on-chip MACRObus that ties all the megafunctions together through a decoding scheme. Test circuitry and a "standard" test-bus interface are incorporated on each megafunction (a). Each megafunction can be independently tested without using a large number of I/O pins on the chip (b).

Another approach taken by NEC is to add a special on-chip diagnostic bus (the MACRObus) that connects to each megafunction block (ELECTRONIC DESIGN, *May 3, p. 121).* By feeding a control word into the test port, on-chip logic decodes the word, and the desired block to be tested is selected. The test scheme starts with a library of close to 20 complex megacells that each include test-bus interface logic. That logic permits the megacells to connect to the test MACRObus and be activated, tested with externally supplied signals, or be deactivated *(Fig. 2).* Custom megafunctions that incorporate the test logic can also be created and added to the library.

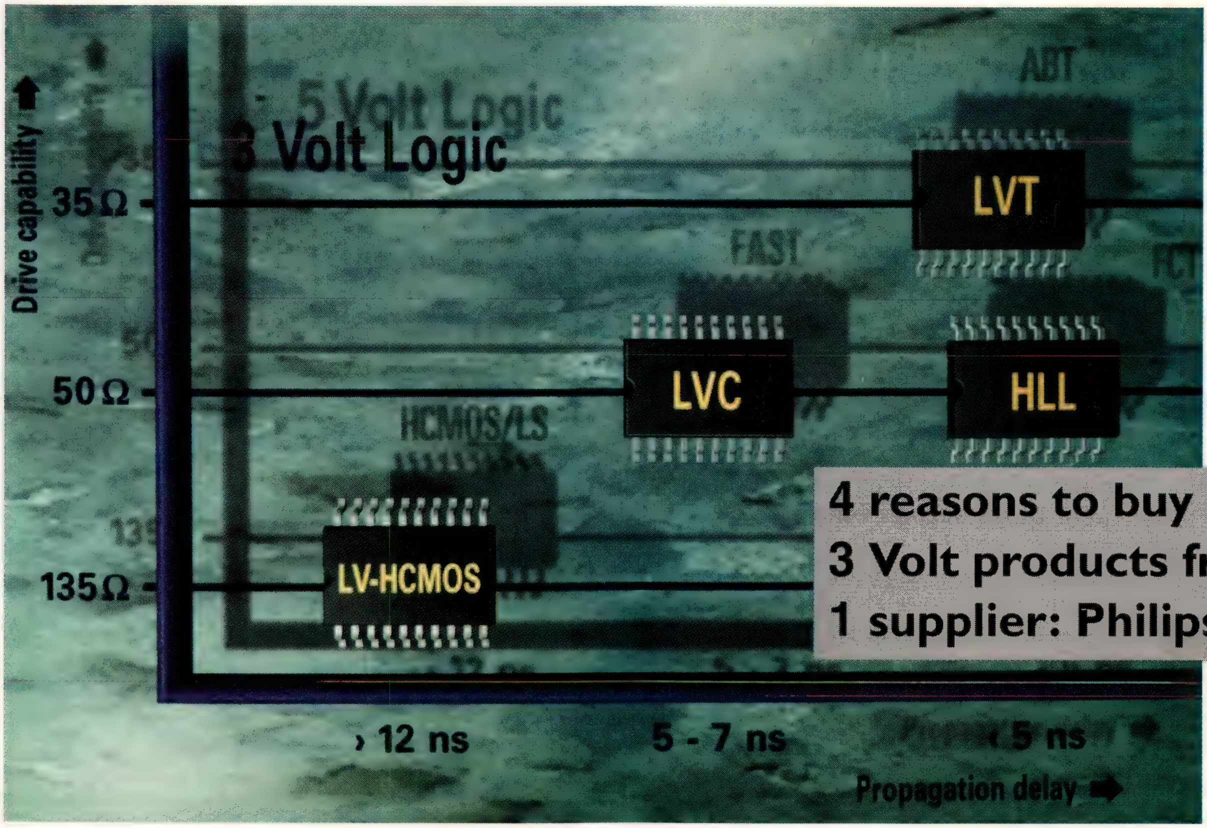
To do the testing, the MACRObus has to be routed to the outside world, either by multiplexing the signals onto pins that aren't needed to run the tests, or by dedicating a group of pins for the required signals. In some previous ASIC designs, multiplexers were typically used on each megacell so that the signals from the megacell can be routed to the outside. The multiplexers route the megacell's signals to the outside, but at the same time tie up those signal lines, thus preventing them from interacting with the rest of the chip.

Because each megacell in NEC's approach contains a separate test port, the main signal interface is free to react with the rest of the chip. The embedded test control logic in each megacell also eliminates the overheads associated with incorporating the logic as a post-design decision. In most previous ASIC designs, test-logic circuitry is usually incorporated as an afterthought and adds considerable overhead to the circuit operation in the form of gate delays.

DEALING WITH DENSITY PROBLEMS

CMOS and biCMOS processes, currently just moving to 0.5-μm design rules for production circuits, were recently applied by several ASIC suppliers to implement CMOS sea-of-gates gate arrays with complexities of up to 1.3 million usable gates (over 1.5 million total gates) and biCMOS arrays with about 300,000 total gates. By mid-decade, those densities will more than double again, hitting close to 4 million gates on a CMOS array, and about 500,000 on a biCMOS chip by late 1995.

The finer-line processes result in both consequences and benefits. As a result of the smaller dimensions, stresses on the thin oxide layers used during chip fabrication require that lower voltages be used. For circuits employing features of 0.5 μm and smaller, most companies have standardized on 3.3 V as the first step down from the long-time 5-V standard. Additional efforts to set standards at still lower voltage levels for future-generation circuits have already resulted in a standard at between 2.4 to 2.7 V. Furthermore, there are ongoing



4 reasons to buy 3 Volt products from 1 supplier: Philips.

1. The LV-HCMOS Family is the 3V equivalent of 5V industry standard LS-TTL and HC/HCT for mid-range speed (10-20ns) applications.
2. The advanced LVC family is aimed at higher speed 3V applications and is compatible with FAST, ALS, ACL and (Q) FACT ranges.
3. Aimed at pure speed, HLL is the world's fastest 3V TTL compatible logic family with performance equivalent to FCT-C 5V logic.
4. New from Philips, the LVT BiCMOS family is geared to applications demanding both speed and drive output capability, and is compatible with ABT to drive heavily loaded backplanes.

Key parameters and features comparison of Philips' 3V logic families

KEY FEATURES	LV-HCMOS	LVC	HLL	LVT
TTL level input	✓	✓	✓	✓
TTL Level output	✓	✓	✓	✓
5 V input capability		✓*	✓*	✓
Forced 5 V output				✓
Live insertion				✓
Input bus Hold				✓

* For transceivers $V_{IN\ max} = V_{CC} + 0.5V$

All four 3V logic families are based on industry standard features to facilitate rapid design-in. And, all 3.3V functions are designed from scratch, rather than recharacterized 5V functions, so they're optimized for low power applications.

Call us today at: (800) 447-1500 ext. 1084 ED

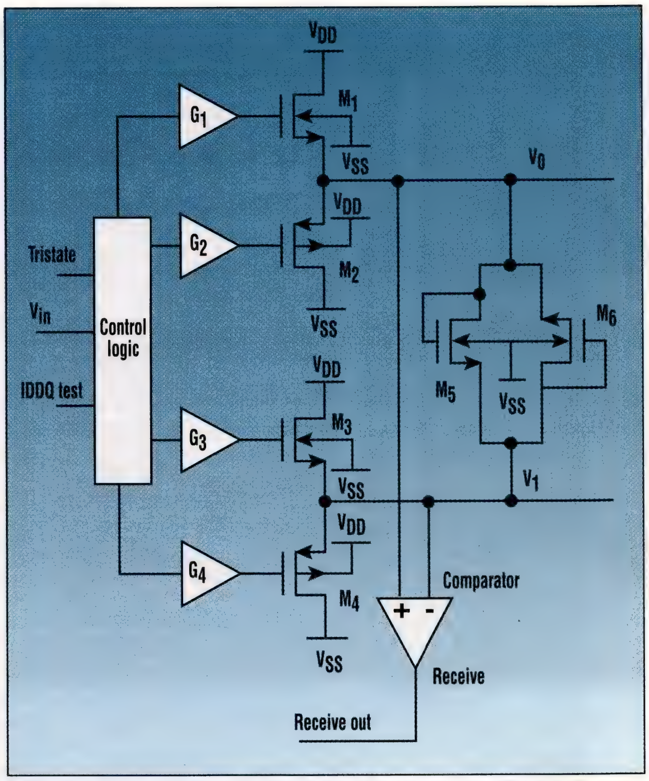
Philips Semiconductors

PHILIPS

discussions for a follow-on power-supply standard at about 1.8 V.

First-generation low-voltage ASICs basically suffered performance losses—typically running at about 60% of the clock frequency possible at 5 V when operated at 3.3 V. That's because the processes used to fabricate them were optimized for 5-V operation. Today's second-generation 3.3-V processes are more optimized for 3.3-V operation and can deliver performance that's comparable to performance from 5-V circuits. Future 3.3-V circuits will employ totally optimized processes that will permit chips to deliver higher performance than possible at 5 V.

Today, most systems still employ 5-V supplies. But many mixed 3.3/5-V systems are starting to appear and will probably be designed for several years until all the support components needed to implement an all-3.3-V system are readily available. Consequently, most array and standard-cell suppliers are adding special interface cells to their libraries—cells that provide 5-V to 3-V and 3-V to 5-V conversion. As a result, many of the forthcoming ASICs will be able to function in systems with mixed voltage levels, employing 3.3 V internally to minimize power, and providing both 3.3- and 5-V I/O lines to interface to the rest of the system.



3. Three power-supply buses running around a mixed-voltage gate array make 3.3- and 5-V system interfaces available to designers. The circuit is used on the soon-to-be-available TC183G array family from Toshiba.

Typical of the mixed-voltage ASIC options is the I/O buffer arrangement available in the forthcoming TC183G family of gate arrays from Toshiba *(Fig. 3)*. They employ three power-supply buses: one for the 3.3-V output buffers and internal logic, another for the 3.3-V input buffers, and a third for the 5-V input and output buffers. Special buffer and level-translator cells in the library provide designers with the proper interface levels to the outside world.

A side benefit of the lower supply voltage is a significant reduction in a circuit's operating power levels. That reduction can also be a key benefit because a complex CMOS circuit operating at frequencies exceeding 100 MHz could consume a considerable amount of power. Even with a relatively low-power consumption level of 0.5 μW/MHz/gate (with a 3.3-V supply), a million-gate chip with 200,000 gates switching at 150 MHz will consume 15 W (the remaining gates operate at much lower speeds so their power consumption is negligible). That power estimate doesn't include the hundreds of I/O buffers or internal loading losses, which could add another 5 to 15 W to the power consumed.

I/O buffers play an important role in future-generation circuits because TTL-compatible signals are too power hungry and too noisy as switching speeds exceed 50 MHz. Furthermore, as signals propagate from chip to chip across a circuit board, new schemes must be applied to deal with the lower supply levels and smaller signal swings. Over the last year or so, low-voltage TTL (LVTTL), Gunning transceiver logic (GTL), and many other interface schemes have been implemented or proposed to improve interface efficiency.

One approach for multichip systems combines a non-standard high-speed interface between chips, and a standard interface on the I/O signals that communicate with the outside world. This approach provides the best of the standard and cus-

REPRESENTATIVE MANUFACTURERS OF CMOS AND BICMOS GATE ARRAYS

Capacities of over 1 million usable gates (CMOS arrays)*
IBM Corp., Somers, N.Y.
LSI Logic Corp., Milpitas, Calif.

Capacities of over 250,000 but less than 1 million usable gates (CMOS arrays)*
AT&T Microelectronics Inc., Allentown, Pa.
American Microsystems Inc., Pocatello, Idaho
Aspec Technology Inc., Santa Clara, Calif.
Atmel Corp., Colorado Springs, Colo.
GEC Plessey Semiconductors, Scotts Valley, Calif.
Mitsubishi Electronics America Inc., Sunnyvale, Calif.
Motorola Inc., Chandler, Ariz.
NEC Electronics Inc., Mountain View, Calif.
Oki Semiconductor, Sunnyvale, Calif.
S-MOS Systems, San Jose, Calif.
Samsung Semiconductor Corp., San Jose, Calif.
Sanyo Semiconductor Inc., Mountain View, Calif.
Texas Instruments Inc., Dallas, Texas
Toshiba America Electronic Components Corp., Irvine, Calif.
VLSI Technology Inc., San Jose, Calif.

Capacities of 25,000 to less than 250,000 usable gates (CMOS or biCMOS arrays)
Applied Micro Circuits Corp., San Diego, Calif.
Fujitsu Microelectronics Inc., San Jose, Calif.
Hitachi America Inc., Brisbane, Calif.
National Semiconductor Corp., Santa Clara, Calif.
NCR Corp., Microelectronics Div., Ft. Collins, Colo.
Texas Instruments Inc., Dallas, Texas (biCMOS)

*Companies in these high-density categories also have lower-density arrays and should be listed in the lower-capacity categories as well.

“Without advertising, everybody would think Ronald was just the name of a former president.”

Mike Quinlan, Chairman, CEO McDonald's (left)

“The remarkable thing is, when you think about McDonald's® you've got to think about people. A friendly crew person welcoming you. Kids, moms and dads having a good time at McDonald's, even a funny clown named Ronald.® Those pictures in your mind are advertising at work.

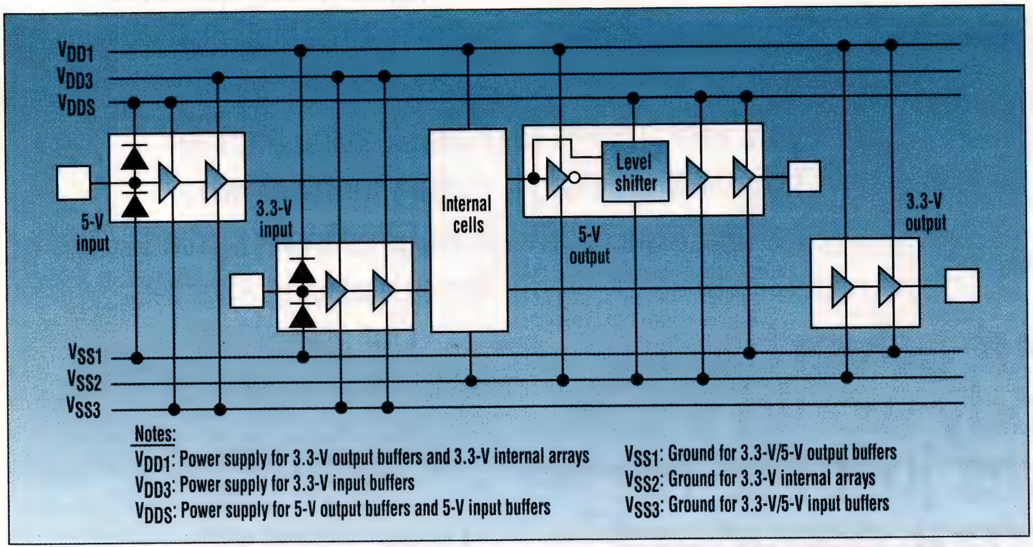
Our advertising is people to people—an invitation from our people to our customers to come in and visit. Personal, friendly, and above all, real.

I'm told there are business people out there who don't believe in the power of advertising. For them, two facts: First, McDonald's is one of the most advertised brands on this planet. Second, McDonald's is the only company listed in the current Standard and Poor's 500 to report combined increases in revenues, income, and earnings per share for more than 100 consecutive quarters since 1965.

Frankly, Ronald and I like to think there's a connection here.”

AAAA
American Association of Advertising Agencies

If you would like to learn more about the power of advertising, please write to Department D, AAAA, 666 Third Avenue, New York, New York 10017, enclosing a check for five dollars. You will receive our booklet *It Works! How Investment Spending in Advertising Pays Off.* Please allow 4 to 6 weeks for delivery. This advertisement prepared by Leo Burnett Co., Inc.



Notes:
V_{DD1}: Power supply for 3.3-V output buffers and 3.3-V internal arrays
V_{DD3}: Power supply for 3.3-V input buffers
V_{DDS}: Power supply for 5-V output buffers and 5-V input buffers
V_{SS1}: Ground for 3.3-V/5-V output buffers
V_{SS2}: Ground for 3.3-V internal arrays
V_{SS3}: Ground for 3.3-V/5-V input buffers

4. This proprietary high-speed bus interface, current-mode transition logic combines the best of BTL and GTL while consuming little power in the inactive mode. Nevertheless, it can switch data at 200 Mbits/s with single-ended drivers and 275 Mbits/s with differential interfaces. Developed by Motorola and available on the company's H4CPlus family of gate arrays, the CMTL I/O option in the design library provides a simple chip-to-chip interface.

tom worlds. Just such an approach was proposed by Motorola in its H4CPlus family of gate arrays. The company has developed a CMOS-based interface scheme called current-mode transition logic (CMTL). It promises chip-to-chip transfer speeds of as much as 200 Mbits/s with single-ended drivers and up to 275 Mbits/s using differential interfaces.

CMTL takes the best of bus-transceiver logic (BTL) and GTL. It provides a CMOS I/O buffer implementation for low-power systems that transfers data faster than GTL and consumes less power. The ability to use lower power is possible because the CMOS CMTL scheme has a dc power dissipation that's defined by only a single-transistor's "off" leakage current. Typical propagation delay through a CMTL interface is just 1 ns, with a dc power dissipation of less than 1 pW. The CMTL circuitry will be embedded in the H4Cplus family of high-performance CMOS gate arrays. Macrocells in the array family's library will let designers implement single-ended or differential structures (ELECTRONIC DESIGN, *July 8, p. 35)*.

With a 5-V supply, CMTL levels have a V_{OH} maximum and minimum of 4.3 and 2.6 V, respectively, and a V_{OL} maximum and minimum of 2.4 and 0 V, respectively. When employed in 3.3-V systems, the V_{OH} levels drop to 2.7 and 1.75 V, respectively, while V_{OL} levels plummet to 1.55 and 0 V, respectively. In addition, the CMTL interfaces can be shifted to link to pseudo ECL (PECL) or GTL by adjusting the internal voltage-reference level *(Fig. 4)*. In a single I/O site, a driver can be implemented to drive up to 24 mA. Two sites can be combined to build a 48-mA driver.

The relatively high power-dissipation level of a CMOS chip operating at high clock rates makes a very strong case for the use of biCMOS technology, because biCMOS gate-power consumption does not increase as linearly with frequency as does the power of a CMOS gate. Thus, although at lower frequencies the power per gate of a biCMOS array is higher than that of gates in a CMOS array, as the operating frequency increases, there will be a crossover point (that point changes for each circuit implementation) at which the CMOS-circuit's power consumption exceeds the biCMOS circuit's. BiCMOS structures, though, offer several benefits even at lower frequencies, depending on the application. For instance, high fanout loads are best driven by bipolar elements because the bipolar devices can better drive the higher load capacitances. Only a few companies sell biCMOS arrays, and array densities are almost an order of magnitude below the megagate capacities of CMOS families. However, as exemplified by the TGB2000E family of biCMOS arrays developed by Texas Instruments, on-chip operating frequencies exceeding 622 MHz are possible. Such high frequencies suit such chips well for telecommunications, computing, and instrumentation applications. Derived from the company's TGB1000 biCMOS array family, the second-generation arrays are made on a 0.7-μm process and include seven base arrays ranging from 14,000 to 150,000 gates. High-speed bus interfaces, such as backplane and CMOS transceiver logic, and 3-V CMOS I/O cells, are all included in the design library.

One direct benefit of the smaller features is the improved performance of the gates. The gate delays are shorter (so operating frequencies are higher) thanks to the reduced parasitic losses of the smaller transistors. Consequently, the denser arrays can operate at higher clock speeds, which, in turn, lets them handle tougher system problems. For instance, today's 0.8-μm array families have typical gate delays of between 200 and 250 ps, and flip-flop toggle rates of about 250 MHz. Forthcoming 0.5-μm array families, such as LSI Logic's 500K family and IBM's CMOS 5L series, have megagate capacities, gate delays of less than 200 ps, top internal clock speeds of about 400 MHz, and system clock rates of 200 MHz.

There are now about a dozen companies offering CMOS or biCMOS arrays with several hundred thousand gates or more, and only two or three suppliers of high-density biCMOS arrays *(see the table)*. In the CMOS arena, IBM and LSI Logic momentarily stand alone with their highest-capacity chips. Each company offers a gate-array and standard-cell family that are claimed to pack over 1 million usable gates onto a single chip. In addition to the almost 20 suppliers of high-density arrays, there are at least as many suppliers of arrays with maximum capacities of less than 50,000 gates.

In IBM's approach, up to five levels of metal can be used to interconnect the logic cells and megafunctions. The large number of layers will let IBM put the high-gate-count arrays or standard-cell-based circuits onto chips that should be smaller than those on arrays manufactured with fewer levels of metal. To get the large number of levels without running into processing limitations, IBM designers developed a "perfect" planarization scheme. The technique planarizes the dielectric layer surface by depositing tungsten plugs into the contact holes on the surface, and next depositing aluminum over the now planar surface to interconnect the logic. This planarization scheme can be repeated layer after layer. The five layers IBM uses can eventually be extended to handle as many layers as the designer needs (for a price).

Along with the higher gate counts comes the need for a larger number of I/O lines. With many of the ASICs, driving wide or multiple buses is a key requirement. As a result, ASIC suppliers are creating chips with a higher I/O line-to-gate-count ratio than in previous generations. However, larger I/O pin counts also means that higher-pin-count packages must be used. Large, ceramic pin-grid arrays are too unwieldy as pin counts exceed about 400 leads. Two alternatives to the leaded packages are options such as tape-automated bonding (TAB) and the up-and-coming ball-grid array (BGA) packages.

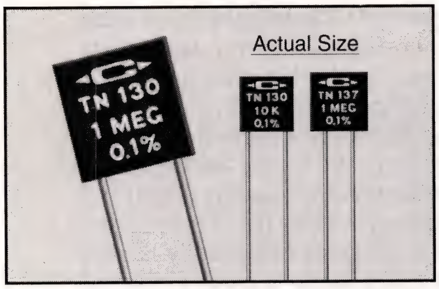
Although TAB techniques can readily handle circuits with 500 or more leads, a manufacturing line, to be economical, usually requires a reasonable volume to run through on a consistent basis due to the tooling and machine setup requirements. Such is not the case with the BGA package and it is seeing a tremendous amount of interest. The only problem for now is that the package has not been standardized yet. There are currently dozens of BGA package options proposed to the standards committees. Once a standard set of BGA packages is defined, the BGAs could become the most popular high-I/O-count package for ASICs.☐

HOW VALUABLE?	**CIRCLE**
HIGHLY	620
MODERATELY	621
SLIGHTLY	622

Use the right Three Phase Solid State Relay
EFRTP
TRTP
AC1
AC2
AC3
L.E.D. CONTROL 5-32V
TRTP SERIES SOLID STATE RELAY
Control in 3-32V
THREE PHASE SOLID STATE RELAY
FUSED COPPER ™
EFRTP SERIES
GENTRON CORPORATION Scottsdale, AZ U.S.A.
GENTRON
1-800-436-8766
FAX (602) 443-1408
Up to 1200v & 50 Amp Compact Size, Faston Terminals
Up to 1600v & 150 Amp Fused Copper™ Construction
THE NEW LEADER IN SOLID STATE RELAYS

CIRCLE 226 FOR U.S. RESPONSE
CIRCLE 227 FOR RESPONSE OUTSIDE THE U.S.

Type TN Lab Grade Low TC Precision Resistors

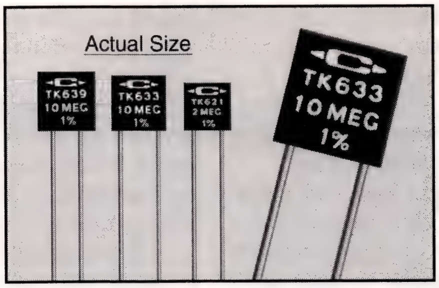


1 K to 1 Meg, Tolerance to ±0.025%
Low TC to 5 ppm/°C, 0°C to 70°C

- **Non-Inductive Design**
- Tolerance of ±0.025%, ±0.05%, ±0.1%, ±0.25%, ±0.50% or ±1%
- Low TC of 5, 10 or 20 ppm/°C, 0 to 70°C
- Space Efficient Radial-Lead Design

For Type TN data, Circle Number 208

Type TK Low TC Precision Radial-Lead Film Resistors

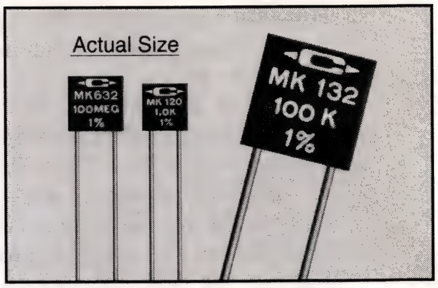


Low TC to 5 ppm/°C, -55°C to 125°C

- **Non-Inductive Design**
- Resistance Range 1 Kohm to 10 Meg
- TC of 5, 10 or 20 ppm/°C, -55 to 125°C
- Tolerance of ±1% (available to ±0.05%)
- Space Efficient Radial-Lead Design

For Type TN data, Circle Number 209

Type MK Precision Power Radial-Lead Film Resistors



0.50 Watt (CK05), 0.75 Watt (CK06)

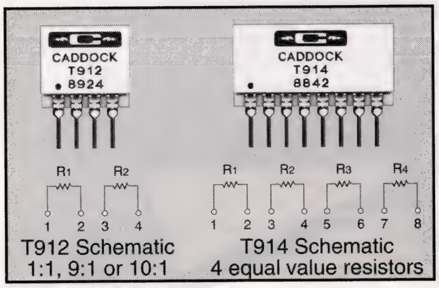
- **Non-Inductive Design**
- Resistance Range 1 Ω to 100 Meg
- TC as low as 50 ppm/°C, -15°C to 105°C
- Tolerance of ±1% (available to ±0.1%)
- Space Efficient Radial-Lead Design

For Type TN data, Circle Number 210

CADDOCK® Resistor Technology

Precision and Ultra Precision Resistors and Resistor Networks with a 25 year record for solving problems across the board!

Type T912 and Type T914 Precision Resistor Networks



T912 Schematic 1:1, 9:1 or 10:1

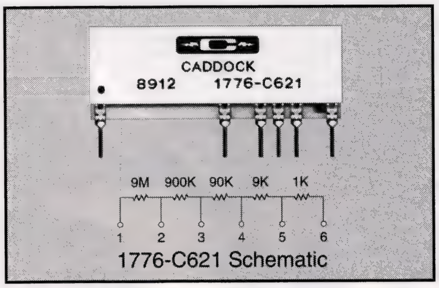
T914 Schematic 4 equal value resistors

Ultra Precise Ratios to 0.01%

- 14 Standard Resistance Values from 1 Kohm to 1 Meg (Custom to 2 Meg)
- Ratio Tolerance from 0.01% to 0.1%
- Ratio TC of 2, 5 or 10 ppm/°C, 0 to 70°C
- Custom ratios available, 1:1 to 250:1

For Type TN data, Circle Number 211

Type 1776 Precision Decade Voltage Dividers



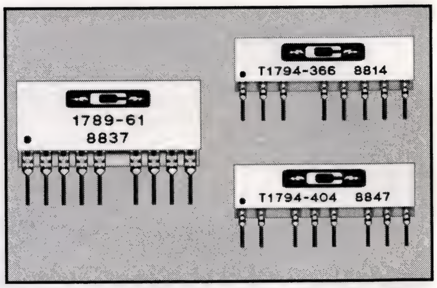
1776-C621 Schematic

Voltage Division 10:1 to 10,000:1

- Ratio Tolerance 0.02%, 0.05%, 0.1%, 0.25% or 0.5%
- Ratio TC of 5, 10, 25 or 50 ppm/°C, from 0°C to 70°C
- Select from 39 Different Models
- Voltage Rating to 1,200 Volts

For Type TN data, Circle Number 212

Custom Precision and Ultra-Precision SIP Networks



Ratio Tolerance to 0.01%

- Resistance Range 0.5 ohm to 50 Meg
- Abs. Tolerance from ±0.025% to ±1%
- Ratio Tolerance from 0.01% to 1%
- Abs. TC of 15 ppm, 25 ppm, 50 ppm or 80 ppm/°C, from 0°C to 70°C
- Ratio TC of 5 ppm, 10 ppm, 25 ppm or 50 ppm/°C, from 0°C to 70°C

For Type TN data, Circle Number 213

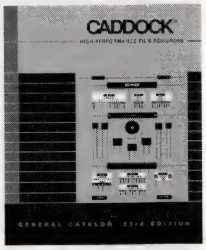
More high performance resistor products from

CADDOCK
ELECTRONICS, INCORPORATED

Please call or write for the 23rd Edition of the Caddock General Catalog which includes specifications for over 200 models of high performance film resistor products.

Applications Engineering
Caddock Electronics, Inc.
17271 North Umpqua Hwy.
Roseburg, Oregon 97470
Phone: (503) 496-0700
Fax: (503) 496-0408

Sales Office - USA and Canada
Caddock Electronics, Inc.
1717 Chicago Avenue
Riverside, Calif. 92507
Phone: (909) 788-1700
Fax: (909) 369-1151



These products are manufactured with Caddock's exclusive Micronox® or Tetrinox® Resistance Film Technologies.

© 1989, 1991, 1992, 1993 Caddock Electronics, Inc.

L-124.023

BY FRANK GOODENOUGH

SiGe, SOI TO LEAD ANALOG, MIXED-SIGNAL PROCESSES

Two emerging processes will provide a glimpse of things to come in analog and mixed-signal process technologies. One, a silicon-germanium heterojunction bipolar-transistor (SiGe HBT) process, is just arriving on the scene. The other, a silicon-on-insulator (SOI) process, is an enabling wafer technology used at the heart of the most advanced complementary bipolar (CB) processes and potentially other advanced analog and digital techniques. These two processes will join their CB, complementary bipolar CMOS (CbiCMOS) and ultra-fast biCMOS counterparts that now dominate analog and mixed-signal IC methodologies.

SiGe ICs WILL GIVE GaAs DEVICES A RUN FOR THEIR MONEY

While today's advanced analog and mixed-signal IC processes take advantage of technology originally developed for digital ICs, they've been adapted to their new tasks by sometimes minor and often major modifications. Examples include fine-line lithography, trench etching, and the SiGe HBT. In a new twist, some of the significant analog-IC improvements are now moving into the digital-IC arena. Examples include RF processes on bonded wafers to handle digital signals in wireless applications, and in the future, in sub-0.25-μm CMOS.

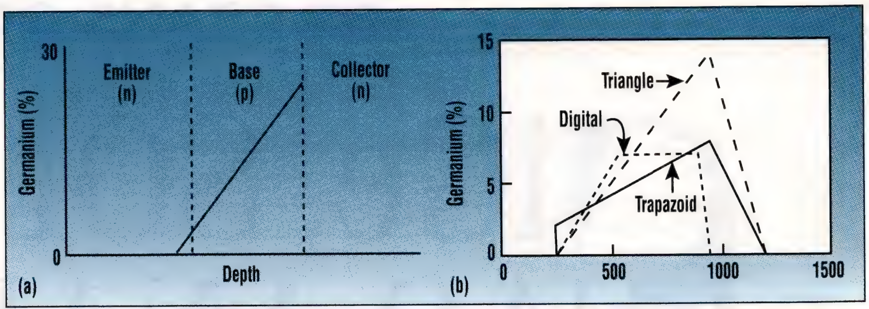
A SiGe method conceived by IBM promises to be the most exciting new analog/mixed-signal process. IBM has built practical npn HBTs, featuring unity-gain cutoff frequencies (f_ts) of 113 GHz, that are compatible with a basic 0.25-μm silicon CMOS process. But more important, the Beta Early-voltage product (βV_A) of these transistors is 48,000. A transistor's βV_A product determines the quality of its current sources (the heart of most analog ICs) and should at least reach into the thousands to be useful for precision analog tasks.

Over the next few years, SiGe ICs may well revolutionize high-speed data conversion. For example, a 1-GHz, 12-bit digital-to-analog converter (DAC) needing just 1 W of power has already been fabricated in a SiGe process. More importantly, the process could potentially give GaAs ICs a run for their money in the RF arena.

Wafer bonding to create SOI films, a laboratory phenomenon just a few years ago, has become a viable and growing technology. In fact, several wafer suppliers and other companies offer such special wafer processing. Moreover, many companies are developing their own wafer-bonding technology. Harris Semiconductor, Melbourne, Fla., and Analog Devices, Norwood, Mass., now offer standard products on bonded wafers, and more are expected in the near future. Harris' process is available on fixed and semicustom arrays. In addition, UTMC, Colorado Spring, Colo., is offering an SOI foundry process.

CB processes, both junction isolated (JI) and SOI, have virtually become bread and butter technologies for most suppliers of analog ICs. Some are second- or third-generation processes with newer generations under development. In addition, new CbiCMOS processes, the ultimate mixed-signal devices, are arriving almost daily. While most CbiCMOS processes use JI, others use SOI. Also, the f_ts of npn transistors in analog/mixed-signal npn-only bipolar processes will continue to climb to new highs with npn-transistor f_ts in submicron mixed-signal biCMOS processes.

Most new and upcoming processes are modular. More and more, the standard product IC and ASIC designer can ask for the mix of device types desired and trade that off against cost and performance. That is, the designer can start with just CMOS or an npn-transistor process, and then combine them to achieve a biCMOS process. Or a pnp-transistor process can be added to the npn-transistor process to achieve a CB process. Or they can all be mixed to come up with CbiCMOS. In fact, the IBM SiGe process is modular, although presently it's limited to silicon CMOS FETs and SiGe npn HBTs. More details on these analog and mixed-signal processes, as well as power semiconductor processes, will be the subject of a future report.



1. Controlling the ratio of germanium to silicon across the base of a silicon-germanium heterojunction bipolar transistor (HBT) at increasing depths from emitter to collector produces a graded-bandgap base (a). This, in turn, produces a pseudopotential, which accelerates the carriers across the base, decreasing transit time. Different grading profiles give the HBT different specifications (b).

SiGe To Benefit Analog ICs

Every so often, a major breakthrough occurs to reinvent the semiconductor industry, such as the arrival of CMOS. The latest of these is currently happening in SiGe. A technology totally compatible with submicron CMOS, it can be used to build HBTs with unbelievable f_ts and equally unbelievable βV_A products. The process will be a boon to digital, analog, and RF IC designers alike. Described in some detail at last month's International Electron Devices Meeting (IEDM), it represents the result of ten years of work by a large team of researchers at IBM's T.J. Watson Research Center, Yorktown Heights, N.Y. The team was headed by IBM Fellow physicist Dr. Bernard Meyerson, who collaborated with Analog Devices during the last two years.

Initially, the SiGe project was aimed at developing transistors with which ECL circuits could be built for mainframe computers. Its goal was to attain the ultimate in speed-power product (minimum gate delay for a given power per gate, or minimum power per gate for a given gate delay). However, as it came to fruition over the last few years, the direction of the project has taken a new tack.

One major force drove the change: The need for the process deserted the team. Advances in the number of gates per die, coupled with the blazing speed of submicron CMOS, indicated to IBM that massive parallelism, not faster logic, was the optimum way to increase processing speed. As a result, they concluded that there would be little need for high-volume production of ECL ICs. In addition, where CMOS just can't cut it and ECL is required, silicon npn and pnp transistors developed by other T.J. Watson Laboratory researchers achieved f_ts of 50 and 13 GHz, respectively. These transistors have been combined in unique complementary-ECL ICs with active pnp pull-ups, and offer a speed-power product half that of conventional ECL circuits using just the process's npn transistors (ELECTRONIC DESIGN, *Sept. 16, p.74)*.

In the "old" IBM structure, the SiGe project would have been "buried" at this point. However, the IBM Research Division now undertakes "commercialization" programs that find profitable applications outside the company for technology developed within the Research Division. Therefore, for about two years, Meyerson's team has worked closely with Analog Devices to investigate SiGe-transistor applicability to analog IC tasks.

The first result of this collaboration is the 1-GHz, 12-bit current-output DAC noted earlier and reported on at last month's IEDM. A true mixed-signal IC, it contains 2854 SiGe npn transistors, 1465 polysilicon resistors, and employs two levels of metal. And the I/O is ECL-compatible. However, the process is also a natural for RF applications where it will compete with GaAs ICs. These chips are

TABLE 1. COMPARISON OF BULK-SILICON, BONDED, DI, AND SIMOX WAFERS

Characteristic	Bulk silicon	Bonded	DI	SIMOX
Wafer bow (μm)	<25	<50	>100	<50
Particle count (particles/wafer)	<30	<30	100-300	<30
Metallic concentration (ppb), typical	25	25	100	800
Defect density (defects/cm^2)	1-5	10-100	10^2-10^3	10^4-10^5
Maximum diameter (in.)	8	8	5	8
Maximum silicon-film thickness (μm)	>100	30	100	5
Thickness control (±μm)	12	0.5	2	0.01

Source: AT&T
Note: DI = dielectric isolation; SIMOX = separation of implantation by oxygen; ppb = parts per billion.

The smallest, most powerful personal programmer you can buy!

Owning the worlds best selling portable programmer/ emulator is just a phone call away. From engine management to Antarctic survey teams, the powerful and versatile S4 goes where others get left behind.

Only
$795
4 Mbit upgrade $150
Full 30 day money back guarantee!

Size: 7.3 x 4.4 x 1.8 inches
Weight: 18 ounces

A 32 pin ZIF socket programs a huge library of EPROMs, EEPROMs and FLASH devices up to 8Mbit. And our unique user loadable Library means that new parts can be added quickly, and at no cost. All software upgrades are free and available for 24hr download from our high speed bulletin boards.

Emulation

See your code running before committing yourself to an EPROM. With S4's powerful and easy-to-use internal emulation system, download your code to S4, press 'EMULATE', and your target system runs in real time as if an EPROM was plugged in to the socket. Use S4's 'EDIT' command to make minor alterations to your code and see the changes happen *immediately* - just one reason why S4 is used by the world's car manufacturers to develop advanced engine management systems in real time! With S4 emulation there's no need for trailing cables or external power sources; earth loop problems are a thing of the past. S4 even emulates RAM.

Remote Control

As well as being totally stand alone and self contained, S4 can be operated remotely via it's serial port at speeds up to 115,200 Baud. We supply you with a FREE disk containing custom terminal software and a pop-up TSR communications utility.

The Company

If you are looking for a supplier with longevity and stability, then you'll be pleased to learn that Dataman has been designing and selling innovative programmers world-wide for over 15 years. As well as having sales and support offices in both the USA and the UK, we supply the world demand for our products via a network of approved dealers stretching from Norway to Australia.

The Package

S4 comes fully charged and configured for immediate use. You get a mains charger, emulation lead, write lead, personal organiser instruction manual, MS-DOS communications software, spare Library ROM and a 3 year guarantee. Optional modules available for serial EPROMs, 40 pin EPROMs and microcontrollers.

Availability

S4 is always in stock. Phone through your credit card details to ensure *next working day* delivery. Full 30 day no-risk refund.

DATAMAN
Dataman Programmers Inc

Order hotline:
(800) 328 2336
for same-day dispatch

MasterCard VISA

22 Lake Beauty Drive, Suite 101, Orlando, FL 32806, U.S.A. Telephone: (407) 649-3335; Fax: (407) 649-3310; BBS: (407) 649-3159 24hr; Modem: V32bis/16.8K HST
Station Road, Maiden Newton, Dorset DT2 0AE, UK. Telephone: 0300 20719; Fax: 0300 21012; Telex: 418442; BBS: 0300 21095 24hr; Modem: V32bis/16.8K HST
CIRCLE 194 FOR U.S. RESPONSE CIRCLE 195 FOR RESPONSE OUTSIDE THE U.S.

built on 8-in. wafers; most GaAs RF ICs are built on 4-in. wafers. The economics of scale are obvious.

Because these transistors have BV_{CEO}s of less than 5 V, they're practical for today's analog ICs (in the past, high-performance analog circuits were the domain of ±15-V power rails). Furthermore, most of the discrete RF circuits that will be replaced by SiGe ICs have never used ±15 V, except in power stages.

Judging by the successful integration of the IC DAC, these SiGe npn HBTs are good analog transistors. Not only do they offer f_ts an order of magnitude greater than those available on the most advanced processes used today for analog ICs, but their βV_A products run one to four orders of magnitude better. That puts them in a class with devices made from 20-to-30-year-old 40-V standard bipolar processes with 300-MHz f_ts. However, the BV_{CEO} of the SiGe npn transistors runs between 1.5 and 3 V. Because the Early voltage tends to be proportional to BV_{CEO}, the bV_A product of most low-voltage (5 to 10 V) high-f_t silicon transistors is under 1000 (ELECTRONIC DESIGN, *Jan. 9, 1992, p. 59).*

UHV/CVD SiGe HBTs

To create SiGe HBTs, IBM uses ultra-high-vacuum (UHV) chemical-vapor deposition (CVD). A SiGe HBT consists of an npn transistor that's modified by depositing one or more thin layers of SiGe film (each a few tens of Å thick) on its base, creating what is called a graded-bandgap base. The multiple layers of film, each layer with a different Ge/Si ratio ranging from 0 to 25%, controls the profile of germanium across the base from the emitter to the collector *(Fig. 1a).* The graded bandgap across the base forms a "pseudopotential" as great as 20,000 V/cm, which accelerates the carriers across the base. This potential dramatically reduces the base transmit time, producing high device f_ts.

TABLE 2. SOI APPLICATIONS AND WAFER REQUIREMENTS

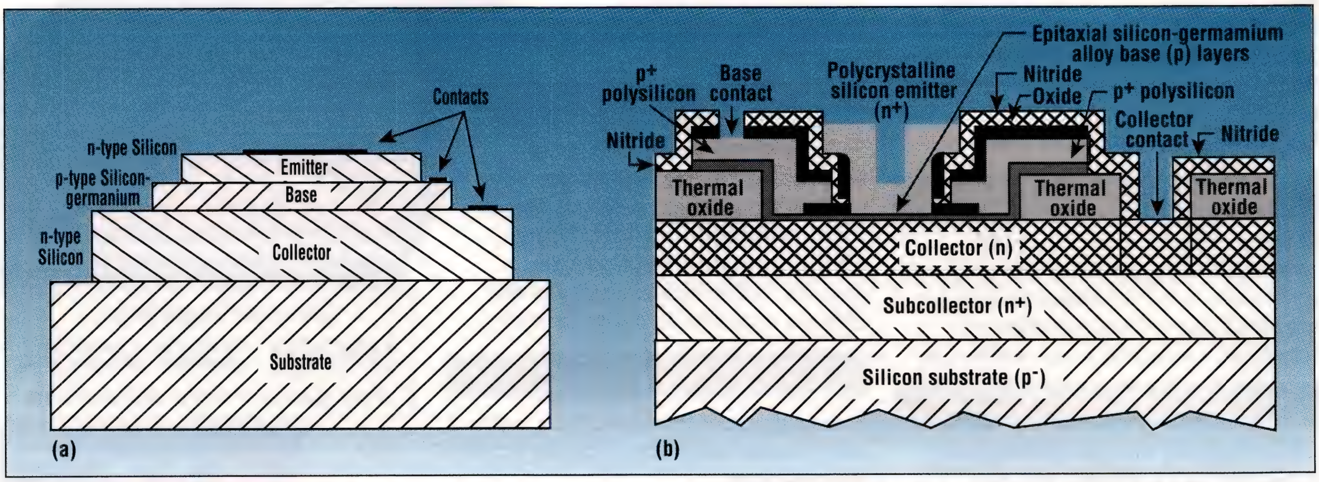
Device type	Silicon-film thickness (μm)	Thickness control (±μm)
High-voltage power	20-200	0.5
Bipolar (analog and mixed signal)	1-5	0.5
biCMOS	1-3	0.2
Sensors	0.5-10	0.05-0.5
Low-voltage power	0.3-1	0.1
Microwave	2	0.5
Fully-depleted CMOS (0.2 μm)	0.05	0,01

Note: SOI = silicon-on-insulator

The differences between the crystal structure of the silicon and the germanium (the atoms in the crystal lattices of the germanium don't line up with those of the silicon) causes strain at the junction. Meyerson's team discovered that by changing the profile of the SiGe grading across the base, in turn changing the strain, they could optimize the transistors for different applications *(Fig. 1b).*

The trapezoidal profile in the figure results in low strain, a moderate Early voltage, and a moderate f_t. The digital profile results in low strain, moderate V_A, and high f_t. However, the triangular profile results in a high strain, high V_A, and high f_t. The 1-GHz DAC using the trapezoidal profile gives the DAC an npn transistor with a minimum f_t of 46 GHz (IBM estimates an f_t of at least 60 GHz when the process is fully characterized), a V_A of 70, a β of 77 (and thus a βV_A product of 1925), and a BV_{CEO} of 3.5 V.

Similar pure-silicon npn transistors built on the same wafer, but without germanium on the base, offer an f_t of 31 GHz, a V_A of 56, a still significantly high βV_A product of 1176, and a BV_{CEO} of 4



2. Silicon-germanium (SiGe) HBTs can be built using conventional molecular-beam epitaxial apparatus to form "classical" mesa structures (a). However, the equipment is not compatible with today's CMOS processes. IBM developed a graded-bandgap SiGe HBT, a planer structure that's compatible with sub-micron CMOS technology (b). The epitaxial SiGe alloy base "p" layers are grown by an ultra-high-vacuum/chemical-vapor-deposition process.

NCR

FAST Track to FAST SCSI

0's Challenges. The 90's demand higher vels of performance and faster delivery an ever. Time-to-market, technological emands, and changing user needs make st, simple SCSI seem as elusive as the orizon. To stay ahead in these challenging nes, you need products you can count on, ith proven ability to deliver the quality and liability your customers require.

90's Products. After over a decade of industry leadership, NCR is still working hard to meet your needs and the challenges of the 90's. The NCR 53C90 family of SCSI Controllers is constantly evolving, implementing and offering state-of-the-art products. For example, the NCR 53C90 family supports multiple bus architectures, advanced SCSI-2 commands, fast SCSI data transfers and provides our exclusive TolerANT® SCSI driver and receiver technology, for reliable data transfers in every SCSI system.

90's Solutions. The SCSI challenges of the 90's can't be solved with silicon alone. NCR quality and service provide you with the competitive edge that can make your industry leading designs a reality. Whether you require SCSI-1 or fast SCSI-2, in any system architecture, NCR has the product to meet your needs today. You can count on us to keep you on the fast track with the right technology, at the right price, at the right time for all your SCSI requirements.

The NCR 53C90 Family

Proven Performance for the 90's and Beyond

NCR SCSI: Real Products, Real Solutions, Real Fast!

SCSI	FAST SCSI*	*NCR Fast SCSI devices transfer SCSI data at 10 MB/s synchronous or 7 MB/s asynchronous
53C90A	53CF90A	Single-bus architecture; SCSI sequences controlled by hardware state machine to minimize host intervention
53C90B	53CF90B	Adds pass-through parity for increased system reliability
53C94	53CF94	Adds split-bus architecture for more flexibility
53C96	53CF96	Adds support for differential transfers

For more information about NCR SCSI products and a free poster, call 1-800-334-5454.

INCREASING SCSI RELIABILITY
TolerANT
ACTIVE NEGATION TECHNOLOGY

CIRCLE 250 FOR U.S. RESPONSE CIRCLE 251 FOR RESPONSE OUTSIDE THE U.S.

V. The βV_A product of the npn transistors built using the triangular profile reached 6160, and their f_t reached 46 GHz.

Essentially by controlling both the percentage of germanium and its profile, engineers can "tune" the SiGe process for the application required by the transistor. ECL gate delays measured in a ring oscillator driving a 5-fF load and using just 1 mA of switch current run about 22 ps for the triangular-profile SiGe devices; the pure silicon npn transistors run at 80% of that speed.

While researchers outside IBM are also working on SiGe HBTs, their devices have all been built using "classic" mesa structures similar to those employed for III/V-material HBTs *(Fig. 2a)*. Such structures, grown with conventional molecular-beam epitaxy (MBE) equipment, aren't compatible with the planar bipolar and CMOS processes employed by today's semiconductor industry. On the other hand, the IBM transistors are planar devices *(Fig. 2b)*. They're fabricated on a submicron CMOS process with just one more, though vital, step—UHV/CVD.

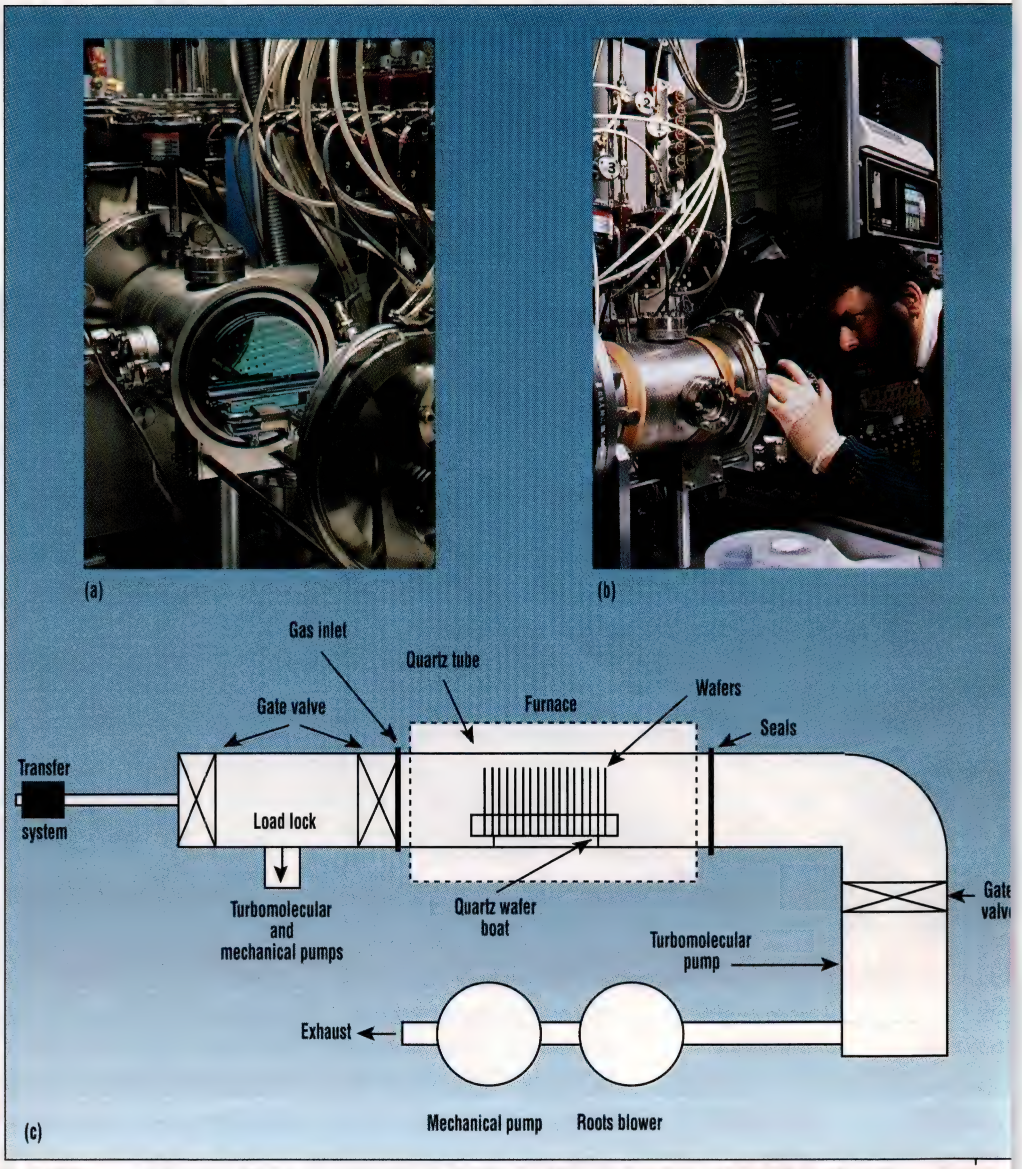
A SILICON GIANT STEP

The SiGe layers grown on the base of the npn transistor that create the heterojunction consist of epitaxial films. And most epitaxies are grown at temperatures of over 1000°C to maintain interfacial purity. This is the technology used to build the SiGe mesa HBTs. However, once a process has started to build bipolar silicon or MOS transistors on a wafer, the devices can't be exposed to temperatures that high. If that happens, previously implanted dopants will continue to diffuse vertically and laterally into the wafer, destroying device structures.

Meyerson and his team determined that if the deposition could be performed below 600°C, the damaging diffusions would not occur and the deposition could be performed at the lower temperatures if it were done in an ultra-high vacuum. However, no equipment existed to do the job, so they designed and built their own UHV/CVD apparatus *(Fig. 3)*. It operates at about 500-550°C and at a vacuum of just 1 millitorr.

Though they built the initial apparatus, the team needed more, but were unsuccessful in finding someone that could handle the project. Nevertheless, one company, Leybold AG, Hanau, Germany, worked closely with the team and finally developed a commercial version of the IBM apparatus. It now markets the apparatus under a license from IBM, selling it for about $1,000,000 each, or less than 1% of the cost of a submicron CMOS fabrication structure. Versions for handling 5- and 8-in. wafers are available.

While the version of the process used for the



3. An IBM research team on silicon-germanium, headed by Bernard Meyerson, designed and built the first ultra-high-vacuum/chemical-vapor-deposition apparatus (a). Meyerson is shown inserting wafers into the apparatus (b). The wafers enter the apparatus through a load lock via the transfer system (c).

DAC represents the first device for commercialization, others will follow. For example, cutting the collector current from 1 mA to 100 μA still leaves an npn transistor with an f_t of better than 10 GHz. Similarly, the f_t can be traded off for a higher BV_{CEO}, and thin-film resistors or metal-oxide-metal MOS capacitors can be added. The V_{BE}s of the HBTs used in the DAC typically match to within 100 μV. They can be "tuned" to provide a differential long-tailed pair with an offset-voltage temperature coefficient approaching zero by changing the grading on the base of the HBTs. Alternatively, the HBTs can be tuned to provide greater speed at 77K. And because RF transistors don't require the beta Early-voltage product of data converters, they can be optimized for other characteristics.

Although still in the development stage, SiGe pnp transistors with an f_t of 55 GHz have been developed. On top of that, SiGe modulation-doped FETs (MODFETs) were created. The MODFETs are potentially faster than the silicon n- and p-channel MOS devices from the CMOS process on which the HBTs are built. Thus, if the silicon CMOS isn't fast enough to meet the needs of future biCMOS (SiGe bipolar) ICs, designers may be able to move to the MODFET. Alternatively, they may opt to choose a complementary ECL device built with the HBTs. Another possibility is SiGe CbiCMOS on SOI. In fact, some of the HBT development work has been done on SOI wafers.

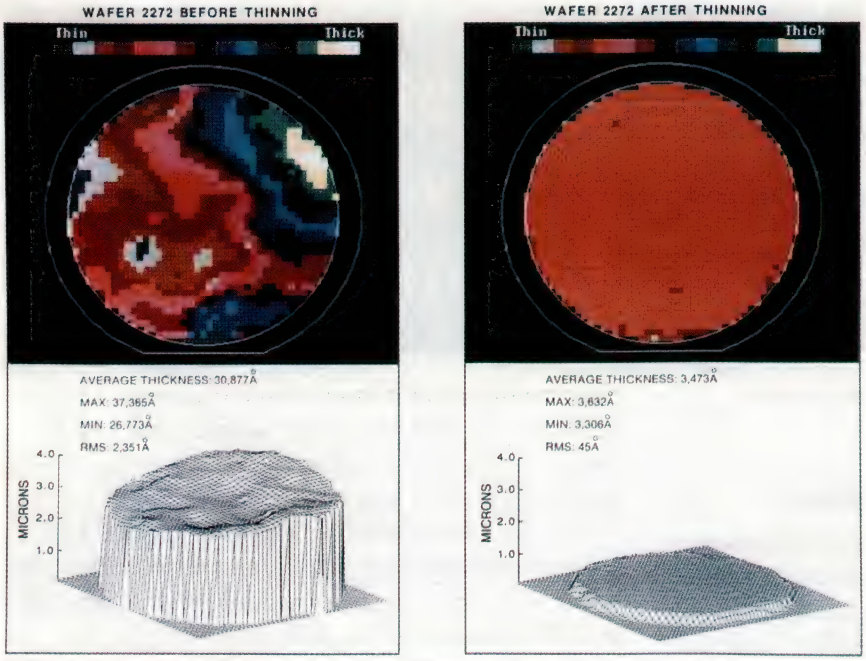
A practical demonstration of direct wafer bonding, or "bond and etchback silicon-on-insulator (BESOI) technology," burst on the scene just two years ago. That's when Harris announced its 12-V high-frequency CB UHF-1 process. which is built on bonded wafers (ELECTRONIC DESIGN, *Dec. 19, 1991, p. 35, and Jan. 9, 1992, p. 62).*

Wafer bonding started when it was first proposed by an IBM paper at the 1985 IEDM. Now the technology should soon become the starting material of choice for high-speed/wideband and RF ICs. Moreover, it can be used for high-performance mixed-signal ICs as well, particularly if designers add CMOS to the CB processes now on the wafers. And by replacing the SIMOX (separation of implantation by oxygen) process, it could become the starting material for deep sub-0.5-μm, fully-depleted, digital CMOS ICs. On the other hand, wafer bonding may not replace conventional polysilicon-handle DI for high-voltage ICs.

Since the Harris UHF-1 announcement two years ago, SOI has grown rapidly with more developments on the way. While Harris developed their own bonding process, there are now at least three OEM wafer suppliers: Shinitsu of Japan (SEH America, Vancouver, Wash.); Aracor, Sunnyvale, Calif.; and AT&T, Reading, Pa., which is a new entry to the fray. Aracor and Hughes Danbury Optical Systems Inc., Danbury, Conn., offer wafer-thinning services.

Analog Devices recently announced ICs on a process called XFCB, similar to Harris' UHF-1 process (ELECTRONIC DESIGN, *Sept. 2, pp. 39 and 48).* The company is also building their CMOS analog switches on a 30-V bonded-wafer process. Both processes use Shinitsu wafers. In addition, UTMC recently announced a foundry service based on a 30-V wideband/high-speed CB process. Also based on Shinitsu wafers, it's being shown to both fab-less analog IC houses and those with fab facilities. It complements the Harris process, which is available on an ASIC basis. As a result, analog and mixed-signal system houses with internal IC-design teams can now move easily to an ultra-fast low-voltage process or a slightly slower ±15-V process. If the UTMC process is picked up by IC houses, system designers should be seeing a number of high-performance standard-product ICs from the UTMC process in the future.

Bonded wafers represent one the three most popular forms of SOI technology, the other two being polysilicon-handle dielectric isolation (usually just called DI) and SIMOX. All three isolate one or more active or passive devices on a die by surrounding them on four



4. Using a plasma-assisted chemical etching (PACE) process developed by Hughes Danbury Optical Systems, silicon film is thinned on bonded wafers to less than 100 nm (1000 Å). Before the Acuthin process starts, a thickness map and topographic plot of the wafer is made to determine how much silicon to remove (left). A second map and topographic plot are made after thinning (right).

Introducing the world's smallest PMT–another big idea from Hamamatsu.

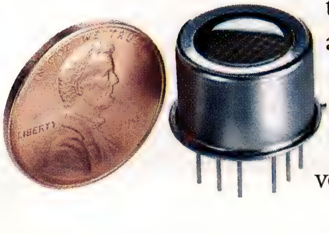
Leave it to Hamamatsu to pack the advantages of a PMT into a tiny TO-8 package that mounts directly on a printed circuit board. Imagine the big benefits it can bring to your space-critical applications.

The new OPTO-8.
PMT performance in a TO-8 package.

Hamamatsu's tiny OPTO-8 delivers performance that challenges the best visible and UV sensors ten times its size, including APDs. In fact, OPTO-8 requires less power, has greater gain per volt and temperature stability, and delivers better overall performance per unit of area than any APD.

OPTO-8 also has such fast time response characteristics that it can redefine your system's performance. And because it's so small and easy to design with, you can capture PMT power in applications where you never could before.

OPTO-8. Another big idea in visible and UV sensor technology from Hamamatsu. To discuss your needs with a Hamamatsu applications engineer, call us at 1-800-524-0504, Ext. 100.



HAMAMATSU

360 FOOTHILL ROAD, P.O. BOX 6910, BRIDGEWATER, NJ 08807
International Offices In Major Countries of Europe and Asia

See Us at Booth #1207-1209
OE/LASE Trade Show

CIRCLE 236 FOR U.S. RESPONSE
CIRCLE 237 FOR RESPONSE OUTSIDE THE U.S.

sides and the bottom with silicon dioxide in multiple "containers" usually called tubs. The tubs are produced first and the devices are next implanted/diffused in them.

DI offers numerous advantages over JI, depending on the application. Basically, the oxide isolation provided by these wafers produces a substrate for monolithic ICs functionally similar to that offered by hybrid ICs built on ceramic substrates. SOI permits a process engineer to create an IC technology that can be used to build any mix of active and passive devices, just as in a discrete design. It eliminates dc parasitics that simplify the mixing of vertical npn and pnp transistors to form a CB process while simultaneously reducing ac parasitic capacitance, raising transistor bandwidths.

Each of the these three SOI processes starts with bulk-silicon wafers. Some versions require pre-processing. However, as a result of diverse fabrication techniques, each produces wafers with different physical characteristics and different flaw levels. The disparate characteristics offer advantages and disadvantages relative to each other, to bulk silicon, and to their applications.

Typical applications include high- and low-voltage power ICs, bipolar-junction-transistor (BJT) ICs, biCMOS ICs, 0.2-μm fully depleted CMOS ICs, microwave ICs, and sensor ICs. SOI processes produce such characteristics as a wafer bow, a lack of wafer cleanliness (including both particle counts and surface concentration of metallic materials), a poor defect density, a limited maximum wafer diameter, a maximum silicon-film thickness, and the need for film-thickness control (thickness tolerance). *Table 1* compares these characteristics for the three SOI processes.

The high (> 100 μm) bow in the DI wafers created during manufacturing provides significant problems in automated machine handling of wafers and also eliminates them from processes using submicron lithography. However, the less than 50-μm bow offered by bonded and SIMOX wafers permits submicron lithography. As DI wafers get larger, the bow increases making any wafers larger than 4 or 5 in. in diameter ineligible for sub-1-μm lithography. In addition, no equipment exists for volume deposition of polysilicon on wafers larger than 5 in. in diameter.

Useful silicon-film thickness and the tolerance required on it are functions of the application. However, a good rule of thumb states that film-thickness tolerance should be ±10% of the nominal thickness of the silicon. Unless using a resurf process, which stands off the voltage laterally, high-voltage ICs need a thick silicon film (20- to 200-μm thick as a direct function of the voltage) to stand off the voltage vertically.

On the other hand, fully depleted sub-micron CMOS needs very thin silicon with a very tight thickness tolerance *(Table 2)*. Bonded wafers stand out for most applications except for vertical high-voltage devices. That's because the thick layers of silicon film require the etching of deep and narrow trenches, with 30 μm presently representing a practical maximum.

For fully depleted silicon, from the point of view of thickness and thickness control, SIMOX appears to be the winner. However, its internal defect density, caused by non-recrystallization of the silicon from damage during oxygen-ion implantation, works against it. Now, new proprietary wafer-thinning processes may let bonded wafers replace SIMOX wafers. Minority-carrier lifetimes are also significantly reduced by the crystal damage to the SIMOX-wafer's silicon making them unsuitable for bipolar devices. Their main application at present is radiation-hardened SRAMs.

While DI wafers now dominate analog-SOI applications, such as high-speed op amps, bonded wafers are coming on strong. On the other hand, DI may keep its hold on high-voltage applications for some time. These range from power-supply and motor-control ICs to telecommunications chips and optically isolated solid-state relays.

Other advantages of bonded wafers over SIMOX include the ability of the process designer to select almost any type of doping for the silicon film. They also include the ability to select oxide thickness, handle-wafer doping, and crystal orientation (<100> or <111>). In addition, both the handle and the prime wafer can be processed prior to bonding to realize device structures not possible by other techniques.

AT&T is currently offering 4- and 5-in. wafers, and 6-in. wafers are expected later this year. The company classifies the film thickness as Thick-, Thin-, and Ultra-thin SOI offerings, for respective film thicknesses of 10-150 μm, 2-10 μm, and 0.07-2 μm. Film thickness variations are ±15%, ±0.5, and ±0.02μm, respectively. According to AT&T, a company building a CMOS IC can get enough more good die from a bonded wafer (compared to a bulk wafer) to justify the cost of paying $380 per wafer instead of $36 per wafer.

SEH America (Shinitsu) offers 4-, 5-, and 6-in. wafers with film thicknesses/thickness variations of 0.5-0.7 μm/±0.5%, 8-20 μm/±2%, and >20 μm/±10%, respectively. They also offer 4-, 5-, and 6-in. wafers with a 525-μm/±25% layer of silicon, and 4-, 5-, and 6-in. wafers with film thicknesses/thickness variations of 94 μm/±0.5%, 119 μm/±0.5%, and 144 μm/±0.5%, respectively.

WHAT'S ON TAP FOR SOI?

Users and suppliers of SIMOX and DI wafers are not letting bonded-wafer technology take over. But bonded-wafer suppliers are not standing still either: AT&T, while coming on the market with bonded wafers, is also the world's largest supplier and user of DI wafers. Work is progressing in two directions to improve bonded wafers.

For high-voltage applications, SOI is being merged with DI technology. Just enough polysilicon is deposited on the DI wafer to fill the etched V grooves and a bulk wafer is then bonded to the polysilicon surface to form the handle. It reduces the deposition time from 3.5 hours to 40 minutes (upping throughput, and reducing cost and the stress which causes bowing). It also cuts the deposition temperature by 100°C, further reducing bow-producing stress. The process should make possible high-voltage DI wafers larger than 5 in. in diameter sooner than trench-etching techniques are able to go deeper than the 20 or 30 μm now possible on bonded wafers.

On the other hand, thickness control has reached new highs. Using a proprietary process called Plasma-Assisted Chemical Etching (PACE), Hughes Danbury Optical Systems, Danbury, Conn., routinely thins wafers for customers to a silicon-film thickness of less than 1000 Å (0.1 μm or 10 nm) with a tolerance of ±100 Å (10 nm), making it suitable for fully depleted CMOS *(Fig. 4)*. PACE was initially developed to manufacture precision optical components from materials such as glass, fused silica, silicon, and silicon carbide. As a result, it can start with silicon films of any thickness, which should lend it to mixed-signal biCMOS processes needing silicon films on the wafers from 1- to 5-μm thick.

PACE starts by constructing a high-density map, indicating the thickness of the as-received wafer after gross thinning by conventional grinding and polishing *(Fig. 4, again, top left)*. The map divides the wafer into 4096 subsections (64 by 64) and a parallel processor calculates how much material must be removed from each sub-section. The wafer is then passed under the small plasma electrode and each sub section is stopped for a short period of time under the electrode. This dwell time under the electrode is calculated from the measured thickness of the silicon and the known removal rate of silicon by the plasma. After one pass, the complete process can be repeated for greater precision. A topographic plot of the wafer before and after thinning *(Fig. 4, bottom left and right)* and a map of the wafer after thinning *(Fig. 4, top right)* indicate the capability of the process. AT&T's Ultra-thin wafers are thinned on the Hughes PACE process.

MORE SIGE

Fully-depleted silicon may need even thinner silicon films than those provided by the Hughes AcuThin wafers. If so, a process developed by Aracor, which can create a silicon-film between 200- and 300-nm thick, may do the trick.

Prior to oxide growth, a 50- to 60-nm thick strained SiGe etch stop is grown on the prime wafer using MBE. This is followed by a silicon epitaxial layer, which will form the silicon film. The bonding-surface oxide is then grown on the epitaxial layer. This prime wafer is then bonded to the handle wafer and the majority of the prime wafer thinned to 200-350 nm with grinding and non-contact polishing. This reduces the epitaxial layers of silicon and the SiGe film to about 3 μm. The remainder of the prime wafer down to the etch stop is removed by a strain-sensitive etchant, which stops when it gets to the SiGe. The etch stop is removed by non-contact polishing or a non-selective etchant, leaving the 200- to 350-nm thick, MBE-deposited epitaxy in which to build the active devices.

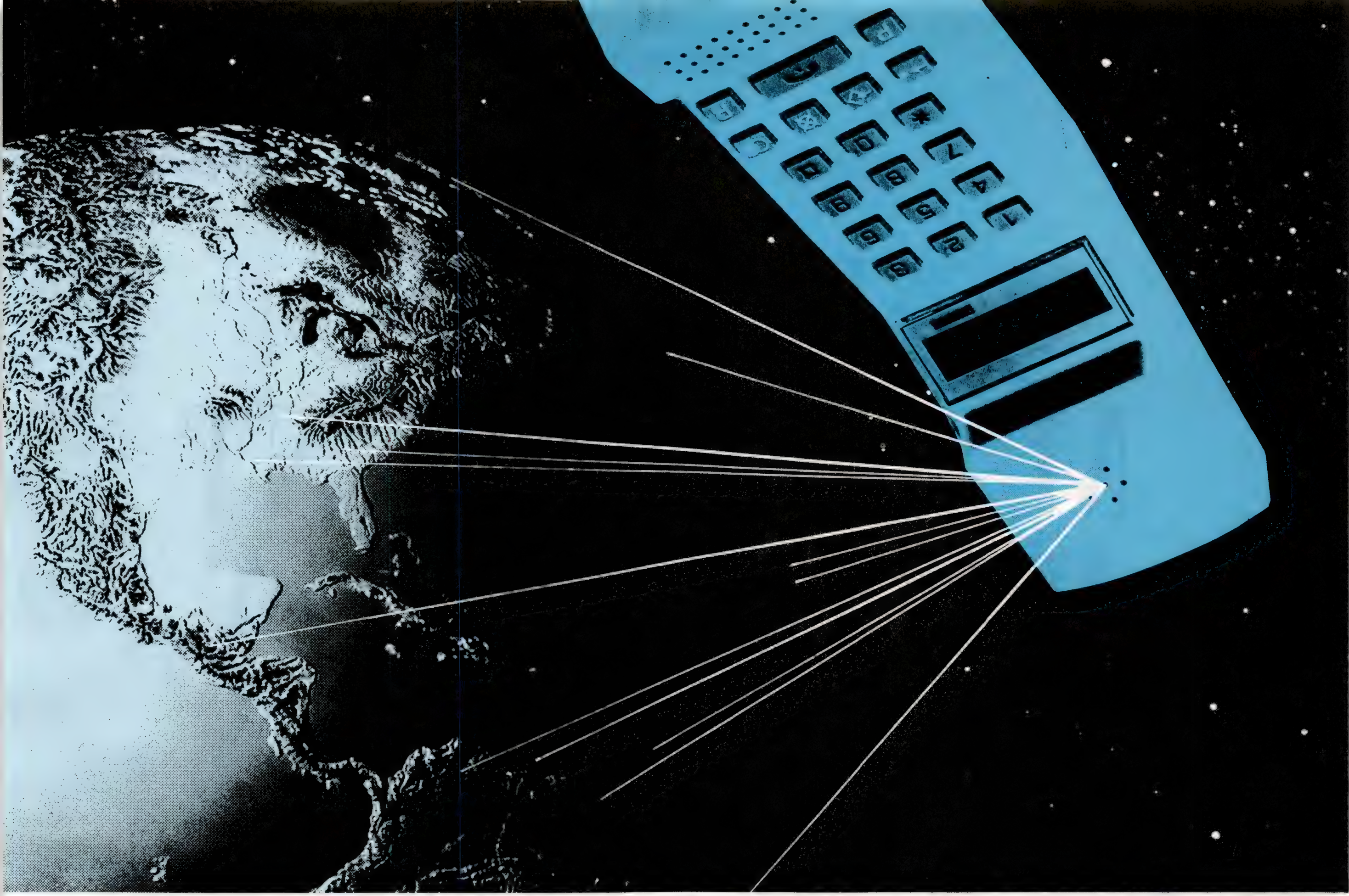
Development work is also ongoing by producers of SIMOX wafers. They must lower the defect densities of both the silicon film and the buried oxide while maintaining its strong point, a uniform silicon thickness on the order of 10 nm. By employing multiple sequential implant and annealing (6 hours at 1300°C) steps, damage to the silicon was reduced by factors of 10 to 100. Other work has shown that the same effect can be realized with a multi-energy implantation followed by a single annealing step—a much more cost-effective technique to follow.

Another factor-of-10 reduction in defect densities from the 10^2-10^3 defects/cm^2 achieved so far for DI will permit SIMOX wafers to be considered for analog applications. If combined with work done to reduce tiny holes in the oxide called pipes—which provide leakage-current paths to the substrate—SIMOX can be considered for biCMOS mixed-signal applications. And the lower pipe density alone lends SIMOX to ultra-large-scale CMOS ICs, such as DRAMs, SRAMs, and even microprocessors—if the defect densities continue to drop. It will be interesting to see if any of the three technologies can make possible die with thick sections for bipolar or biCMOS analog circuits, and thin sections for fully depleted CMOS logic.

SI-SI BONDING

While most wafer bonding consists of joining the oxidized surface of wafers, several applications, such as high-voltage (> 1200 V) transistors and micromachined sensors employ wafers, in which silicon surfaces are bonded to silicon surfaces rather than oxide-to-oxide. In the high-voltage transistors, silicon film on the order of 150-μm thick replaces the expensive epitaxial layer, which can cost as much as four-times that of the basic wafer, or 40 to 50% of the die cost. It has been used in bipolar devices, MOSFETs, and insulated-gate bipolar transistors (IGBTs). The bonded wafers also offer better thickness and resistivity control than high-resistivity epitaxy. Motorola uses them in micromachined pressure sensors and accelerometers to provide hermetically sealed caps for the moving mechanical parts.☐

HOW VALUABLE?	**CIRCLE**
HIGHLY	590
MODERATELY	591
SLIGHTLY	592



B-01.0192

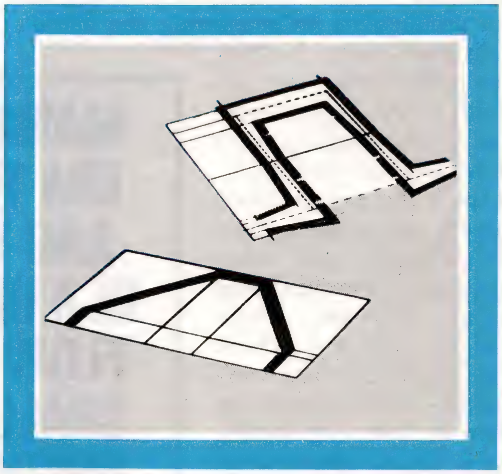
Innovative

High Performance Telecommunications: with the ISDN "digital telephone" system integration of speech, data, image and text has become a reality. Such developing modern systems demand innovative components; VAC has a range of suitable products:

- Signal transformers for interfaces
- Common-mode chokes for RFI suppression
- Modules combining transformer and RFI suppression in one compact housing

Whether for use in terminal equipment or adapters, in network terminations or PBX, VAC inductive components provide a more compact design, easier mounting and reduced costs.

Interested? Contact VAC now for further information.



ISDN-signal transformers from VAC meet current technical specifications, e.g. CCITT, FTZ, BABT and CNET.

VAC
VACUUMSCHMELZE

VACUUMSCHMELZE GMBH, Federal Republic of Germany, D-63412 Hanau
P.O.Box 2253 ☎ (**49) 61 81/38-0 Fax (**49) 61 81/38-26 45 Tx 4 184 863 vac d

Circle 160

BY LISA MALINIAK

PROCESS MANAGEMENT WILL TAP EDA PRODUCTIVITY

Electronic design automation (EDA) strives to meet just one goal: Increase engineering productivity. Early on, EDA vendors focused on honing the features of emerging point tools that provided leaps in productivity over designing by hand. Point-tool technology has matured, though, and exists for almost every phase of the design cycle. Even so, engineers can't achieve maximum productivity by mastering the use of these individual tools. In fact, maximum productivity isn't unlocked until engineering teams can get all of their tools to work together in a seamless fashion.

To exploit the hidden potential in current tool environments, both EDA vendors and users must concentrate on design methodologies and processes. That's why the biggest changes in EDA over the next several years won't appear in the tools themselves, but rather in how engineering teams use them. Previously, choosing tools primarily focused on their ability to accomplish a particular task. Now the emphasis is on choosing the best methodology for each functional block or component, and then getting all of the methodologies to mesh in a smooth, unified flow. Consequently, tool integration, data and library management, and process management will be important problems for engineers.

MANAGING EDA TOOLS AND DATA IN A UNIFIED FLOW WILL CHALLENGE ENGINEERS

Today, the methodology behind a typical electronic design actually consists of many sub-methodologies *(see "Why will engineers need multi-methodology design?" p. 81).* As the complexity of electronic designs continues to increase geometrically, so do the number and variety of sub-methodologies. For example, IC and system designs that can be decomposed into a large hierarchy of individual components and/or contain a number of different modeling languages require a broad range of methodologies in one project. Here's a sampling of methodologies that will be combined to create future designs:

- *Constraint-driven design*: Engineers are confronted with mounting pressures to produce smaller, faster, cheaper, and lower-power designs in less time than ever before. As a result, programmable technologies are seeing more use as TTL and PLD designs are being consolidated into complex PLDs and FPGAs. When these aren't fast enough, large enough, or cheap enough, design teams are turning to gate arrays and full custom ICs to meet their design constraints. At the board level, performance and miniaturization requirements are fueling the growth of multichip modules (MCMs) as an alternative high-density interconnect technology.
- *Analysis-based design*: High-speed boards and MCMs are causing designers to perform more detailed analyses of unintended analog effects. Meanwhile, the growth in portable electronics has more and more designers focused on careful analysis of power consumption.
- *Advanced IC design*: Submicron silicon is

yielding unprecedented gate counts, switching speeds, and power efficiency. These add up to a quantum leap in design complexity, and the need for advanced modeling and analysis capabilities, as well as novel methods to apply these new capabilities to ensure a working IC or ASIC design. These size, speed, and power-consumption trends present special requirements for tools and methodologies, which also spill over into board design. Designers are increasingly turning to hardware description languages and high-level graphical design entry to deal with higher levels of abstraction.

- *Hardware-software co-design*: Increasing software and firmware content in many systems has software groups working closely with hardware design teams. As a result, early prototyping of systems is becoming essential in debugging software in a real-time fashion on emulated system hardware.
- *Design reuse*: To consolidate previously designed functions onto single chips, gate arrays and ICs are incorporating complex embedded cells. In fact, today's ASIC, IC, and system designs are becoming more intricate mosaics of functional blocks derived from various sources. Thus, the accommodation of disparate modeling methods and reuse of previous design work must be carefully considered to get the product into production sooner.
- *Team-based design*: In an effort to accelerate the design process and deal with mounting complexity, team (or concurrent) engineering is replacing individual designers, creating new problems relating to team-based design. As managers contemplate the reality of a five-, ten-, or twenty-person design team, often dispersed over multiple geographic sites, several new requirements emerge. More formalized and automated process and data management becomes paramount, as does the ability to facilitate intra-team communications and to accommodate an increasing number of tools and data formats. The challenges of team-based design are being compounded by tighter budgets and the corresponding shortage of resources—hardware, software, and design engineers.

Tool integration is crucial to the success of the engineering teams that take advantage of these new technologies and methodologies. Getting design software to work together certainly isn't a new problem. But as tool choices multiply and designs expand, tool integration takes on greater significance and becomes harder to solve.

For proper integration, capabilities must be supported across all tools. These capabilities include intertool communication (which, for exam-

WHY WILL ENGINEERS NEED MULTI-METHODOLOGY DESIGN?

On-time delivery of products is becoming more and more difficult due to market dynamics and increasing design complexities. That's why today's electronic engineers are embracing multiple methodologies, with each method optimized for a specific design task. Top-down and bottom-up ASIC design, retargeting previous designs into the latest FPGA technology, high-speed board-level design, high-level system design, and mixed-signal IC design are some of the methodologies being used.

What are the dynamics that are driving this need for so many design styles? The first and most obvious reason for the diversity of methodologies is a corresponding diversity of design objectives. In short, engineers are selecting the best tools for the job at hand and customizing an optimal methodology for each task. In doing so, they're able to exploit the rapid advances made by using the latest EDA technology, thus reducing overall design time and improving quality and functionality.

The second major driving force behind the diversity of methodologies is the growing need to reuse previous design work. A third source comes from the opposite of the diverse design objectives mentioned earlier: a very practical preference by some engineers to use the tools they're most familiar with. This may be necessary to avoid lengthy retraining or the perceived risks for engineers to learn new tools and methodologies. But taken with the trend toward larger work groups, engineering managers may choose to accommodate the diverse preferences of individual engineers if it doesn't impact the success of the project.

The fourth reason for more methodologies relates to previous hardware and software investments. As competitive and economic pressures mount, engineering managers are being asked to stretch their budgets by better utilizing previous investments in platforms and tools.

Finally, one of the most important driving forces of diversity is the far-reaching change created by the emergence of standards such as VHDL and the CAD Framework Initiative (CFI) standards. These standards have changed the EDA landscape by enabling the best-in-class point-tool vendors to thrive. Previously, they were at the mercy of the large EDA vendors who controlled access to their proprietary frameworks.

Such diversity requires a design-automation architecture that can create a single, coherent, and flexible EDA environment that frees engineers to design the way they need to—mixing and matching design methodologies. The enabling architecture for a unified multi-methodology design must blend specific tools so that they work flawlessly within each engineer's methodology of choice, optimized for their particular design challenge.

Contributed by James Griffeth, director of strategic planning for Viewlogic Systems Inc., Marlboro, Mass.

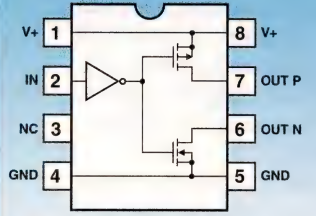
élantec
ANALOG INTEGRATED CIRCUITS

Advancing State-of-the-Art High-Speed Power MOSFET Driver Technology

CMOS Power MOSFET Drivers

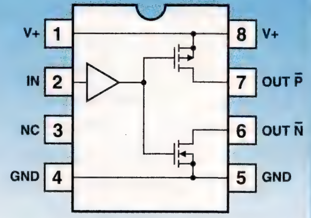
Single Channel, 4.0 Amps Output

EL7104



Non-Inverting
- Isolated Drains
- 20 ns Switching Time
- $1.96 – 100's P-DIP

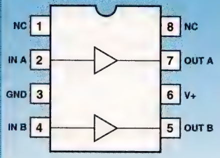
EL7114



Inverting
- Isolated Drains
- 20 ns Switching Time
- $1.96 – 100's P-DIP

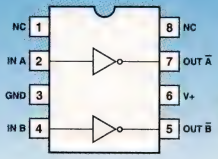
Dual Channel, 2.0 Amps Output

EL7202



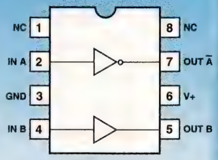
Non-Inverting
- 20 ns Prop Delay
- 20 ns Switch. Time
- $1.55 – 100's P-DIP

EL7212



Inverting
- 20 ns Prop Delay
- 20 ns Switch. Time
- $1.55 – 100's P-DIP

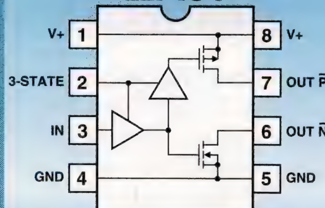
EL7222



Complementary
- 20 ns Prop Delay
- 20 ns Switch. Time
- $1.55 – 100's P-DIP

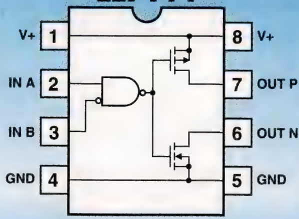
3-State Line Driver / Dual Input Line Driver, 4.0 Amps Output

EL7134



- 20 ns Prop Delay
- 20 ns Switching Time
- $2.40 – 100's P-DIP

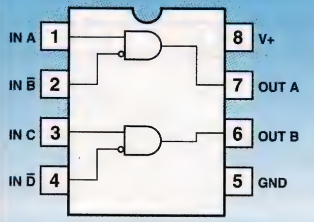
EL7144



- 20 ns Prop Delay
- 20 ns Switching Time
- $2.40 – 100's P-DIP

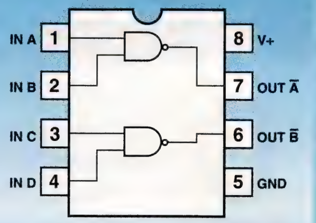
Dual Channel / Dual Input, 2.0 Amps

EL7242



- 20 ns Prop Delay
- 20 ns Switching Time
- $2.25 – 100's P-DIP

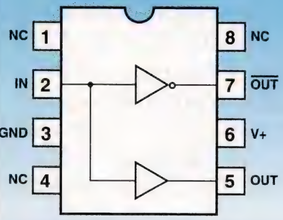
EL7252



- 20 ns Prop Delay
- 20 ns Switching Time
- $2.25 – 100's P-DIP

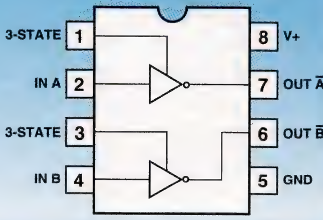
CCD Driver / Dual Channel 3-State Line Driver

EL7182



- Reduced Clock Skew
- 20 ns Switching Time
- $2.25 – 100's P-DIP

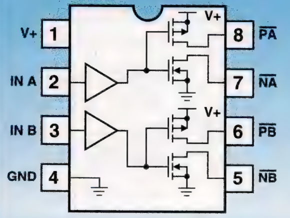
EL7232



- 20 ns Prop Delay
- 20 ns Switching Time
- $2.25 – 100's P-DIP

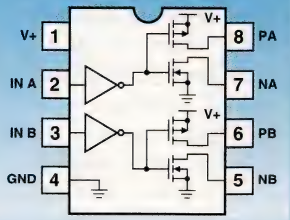
Dual Channel – Isolated Drains, 2.0 Amps

EL7262



- 20 ns Prop Delay
- 20 ns Switching Time
- $2.25 – 100's P-DIP

EL7272



- 20 ns Prop Delay
- 20 ns Switching Time
- $2.25 – 100's P-DIP

Applications: • Clock Drivers • Line Drivers • CCD Drivers • Ultrasound Transducer Drivers • Switching Power Supplies • Bus Driver • Motor Control • Charge Pumps • Pin Drivers • EPROM Programming • Resonant Charging Non-overlapped Switching

FOR SAMPLES CALL OUR APPLICATIONS HOTLINE - (800) 333-6314 ext 311, Literature Only - ext 234

ELANTEC, INC. ▪ 1996 Tarob Court ▪ Milpitas, CA 95035 ▪ (408) 945-1323 ▪ (800) 333-6314 ▪ FAX (408) 945-9305

Authorized Distributors: MARSHALL INDUSTRIES • NU HORIZONS • INSIGHT ELECTRONICS

CIRCLE 228 FOR U.S. RESPONSE   CIRCLE 229 FOR RESPONSE OUTSIDE THE U.S.

ple, would allow users to cross-probe between schematic and simulation), debugging (which might mean single-waveform display for all tools), and accurate design correlation (an example might be finding a problem-causing gate on a schematic by selecting the error on a testability report generated by a test tool). Furthermore, future environments must support the back-annotation of timing attributes extracted from physical layout into the logical design database and onto the schematic.

In addition, the increasing emphasis on design-for-test and design-for-manufacture methodologies requires that engineers have back-end test and manufacturing information early in the design cycle. Without integration, the back-end tools can't pass that type of data up front automatically; data transfer would have to done by hand.

Integration efforts should benefit from the activity in frameworks and standards that will occur over the next several years. It's certain that modeling standards, EDIF, and CFI standards will all undergo change. Commercial frameworks will also evolve. For example, design frameworks that handle local design data will begin to involve more functionality, such as better debugging tools for the framework's programming language. Also, design frameworks need to be integrated with product-data frameworks that manage at the site level.

Much help for integration problems will come to engineering teams in the form of EDA services, which are now offered by many of the major vendors. Nick English, vice president of engineering in the Spectrum Services Group of Cadence Design Systems Inc., San Jose, Calif., foresees EDA evolving into a service-based industry. Although the service component in all EDA companies will increase, the mainline suppliers will lead in this move.

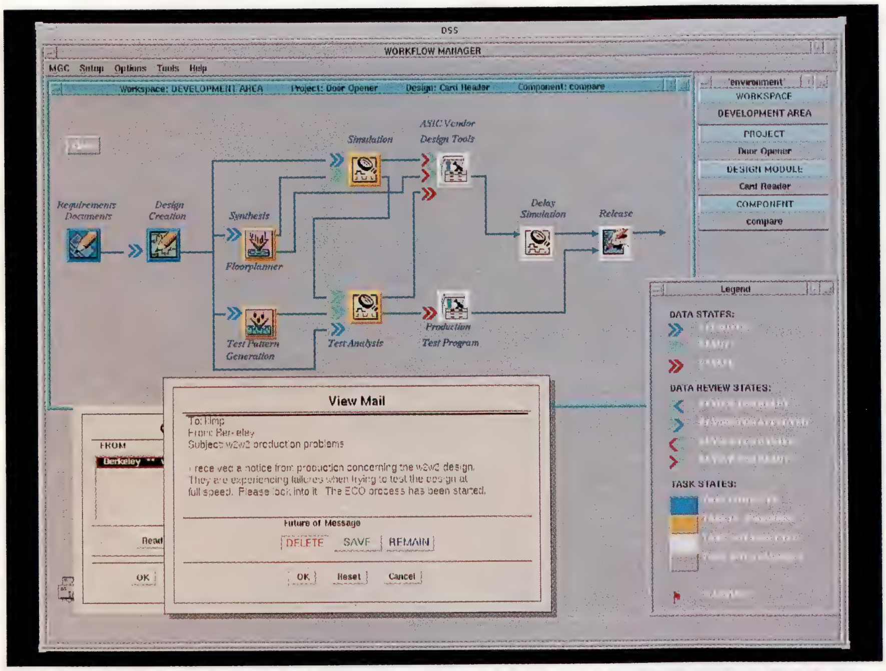
Services will grow in importance because all engineering groups have different needs, and off-the-shelf tools should be tailored to specific applications and company cultures. In the past, service departments provided instruction on how to use various tools. However, that's no longer enough because engineers gain a competitive edge through their design processes. Process training involves tools working together, team leadership, and decision making—all tied together by proper data transfer between tools and divisions.

Data transfer in the form of data and library management poses difficulties for almost every engineer. But for engineering teams working on large, complex projects, the data-management problem can be unbearable. With designs being represented in many data formats, it's essential to import, edit, store, retarget, organize, and control diverse design data.

For example, large corporations need to accurately share global design data across tools. Data from the large corporate parts libraries builds up over the years, and the EDA environment must ensure that approved parts and their associated attributes (part number, cost, package type, etc.) are annotated accurately and consistently on schematics. Actually, enterprise-wide data sharing and management is an important part of the team-engineering approach. It enables a number of functional groups to get involved in the design process early in the development cycle, and to use the design data more productively within their own functional areas.

Library and data management must become EDA-system independent. David DeMaria, president of the U.S. Racal-Redac Inc., Westford, Mass., projects that electronic component-information databases like the one from Aspect Development Inc., Los Altos, Calif., will be a good starting point for creating such independence. But the existing information systems need to be enhanced and made more tool-intelligent. In other words, the databases have to supply more information on each part in a format that can be used directly by design tools.

Dennis Harmon, manager of corporate applications for Viewlogic Systems Inc., Marlboro, Mass., also expects that data management will come from a source other than EDA



View Mail

To: Kimp
From: Berkeley
Subject: w2w2 production problems

I received a notice from production concerning the w2w2 design. They are experiencing failures when trying to test the design at full speed. Please look into it. The ECO process has been started.

Mentor Graphics' services group worked closely with users to develop software that manages data for an entire design flow. A design-flow diagram is customized to each project, and gives users the current status of a design groups' activities. A pop-up window on the right indicates the state of data and tasks with colored arrows and colored icons, respectively. The window at the bottom shows how team members can communicate with each other without leaving an application.

vendors. He points out that there are good commercial data-management systems that can be adapted to help engineers manage the large amounts of information generated in future designs.

To meet the demands of future designs, engineers will need to not only manage data, but also manage their design processes. Every engineering team uses some form of process management, even if they don't think so. For example, an engineer creating a simple board design generally knows what steps he will take to complete the project—draw and verify logic, choose components, place and route, and test—although he doesn't actually write them down. If something goes awry, he simply amends the plan and carries on.

But with long-term, complex, multi-team projects, thorough planning and process management make the difference between success and failure. And as designs grow in size and complexity, a more formal method of process management will inevitably permeate the majority of engineering projects. In addition, capturing a description of the process is key because the knowledge gained from the previous project can be put to good use in the next one.

There are compelling reasons for linking design-process management to a data-management scheme. Many errors can be avoided if the system

HOW AUTOMATED IS DESIGN AUTOMATION?

In their futuristic visions of design automation, engineers may dream that they need only conceptualize an IC and push a button to receive working silicon. In their fantasy design environment, each design tool performs its job efficiently and reliably as the data seamlessly flows from front to back. While things don't work that way in the real world, a recent project at Delco Electronics Corp., Kokomo, Ind., proves that electronic-design-automation (EDA) technology is moving closer to that engineering nirvana.

Late last year, engineers at the Delco Electronics IC Design Center produced working silicon for two chips created in a highly automated environment consisting of behavioral synthesis and high-level physical design tools. The Center built two digital-signal-processing (DSP) chips over a four-month period. One chip is a fast-Fourier-transform (FFT) IC containing 177,000 transistors. The second chip is a Viterbi-decoder IC consisting of 68,000 transistors. Both designs resulted in first-silicon success using Delco's 0.8-μm fabrication process.

The engineering team used the AutoCircuit behavioral synthesis technology from the General Motors Research and Development Center, Warren, Mich., along with high-level physical IC design tools from Cascade Design Automation, Bellevue, Wash. AutoCircuit is based on technology transferred to GM Research from Carnegie-Mellon Univ., Pittsburgh, Pa.

Paul Ainslie, manager of the Delco Electronics IC Center, explains that the tools automated logical and physical design, cutting the design cycle by four or five months over previous projects. He also points out that the high level of automation let the engineers spend more time creating and verifying design behavior, which improved overall chip performance and contributed to first-silicon success.

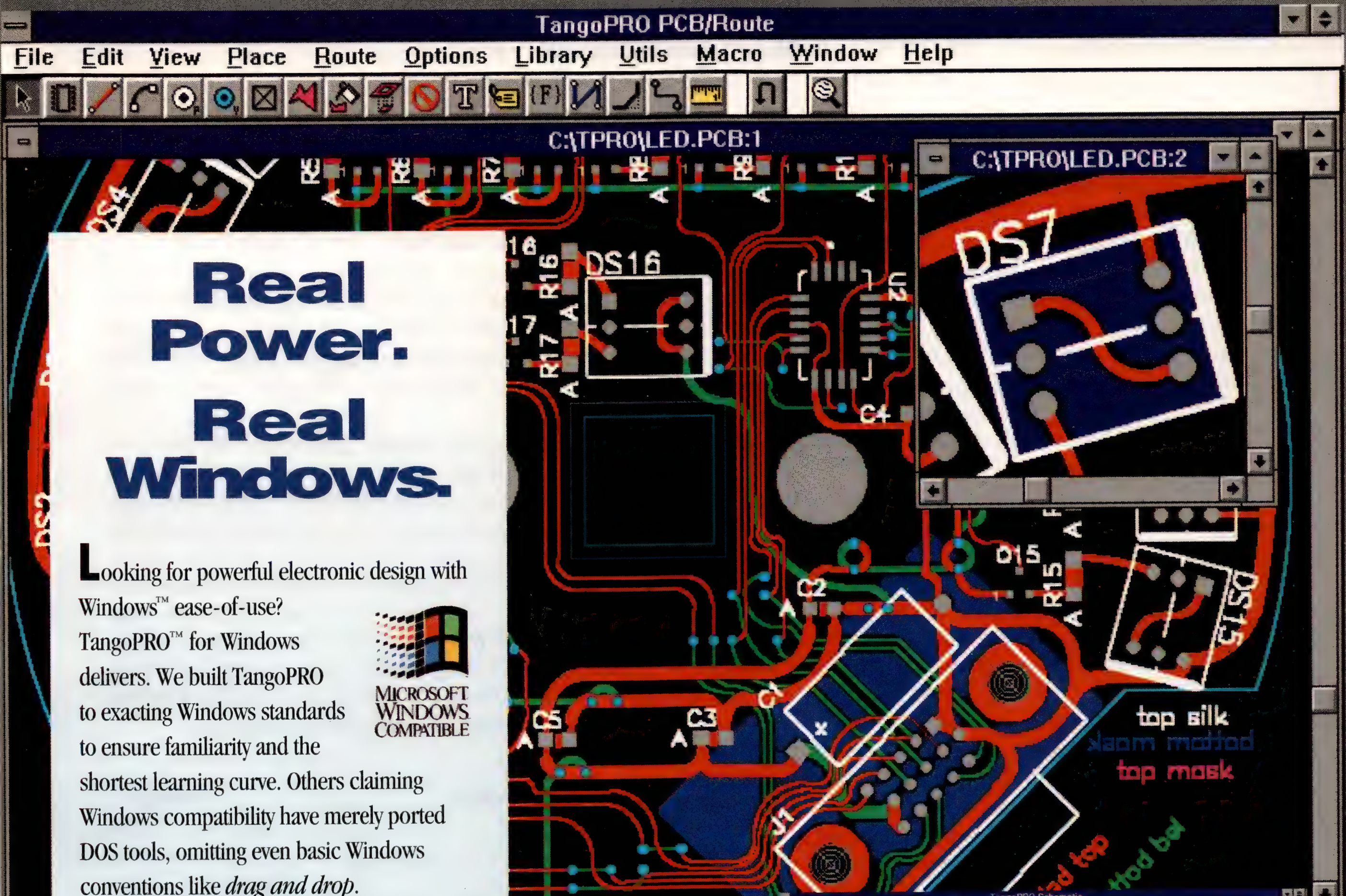
The most commonly used commercial synthesis technology today is logic synthesis, which differs from behavioral synthesis in the level at which it operates. Engineers use logic synthesis to optimize or minimize blocks of logic. With behavioral synthesis, they can work at a much higher level of abstraction. Instead of designing logic, engineers create algorithms (similar to C-language programs) that describe circuit behavior independent of how the circuit will be implemented in logic. Behavioral synthesis tools read the algorithms and automatically make decisions about scheduling operations into different clock cycles, datapath resource allocation and sharing, and register allocation and sharing.

Delco engineers Rob Hunter and Ying Tian used the Verilog language to build their DSP algorithms. Following simulation of the behavioral Verilog, they used GM's AutoCircuit to convert the algorithms into a Verilog net list of datapath modules (such as adders, subtractors, ALUs, and memory), and state-machine and control-logic modules.

The synthesized Verilog net lists were fed directly into Cascade's tools, which automatically compiled all of the datapath modules and synthesized the state-machine control-logic modules. The Cascade tools then placed and routed the modules, and extracted post-layout timing information for gate-level timing simulation in the Verilog simulator. Frank Szorc, senior development engineer at Delco, stresses that one key to the success of using the AutoCircuit synthesis was having physical design tools that directly accepted AutoCircuit's output.

The Cascade physical design environment, called Epoch, tightly integrates module-generation, place-and-route, and timing-analysis tools into a focused, automated solution. Epoch accepts designs captured, simulated, and synthesized with VHDL or Verilog, and automatically turns them into complete layouts.

Delco engineers spent 10 weeks designing and simulating both behavioral algorithms, and only six weeks synthesizing and physically implementing the chips and verifying layout and timing. According to Tom Fuhrman, a staff research engineer for GM, without AutoCircuit they would have spent several months alone just entering schematics, which would have prevented them from delivering the chips on schedule. They were able to skip schematic entry altogether and go directly from synthesis to layout.



Clic... multiple, or drag for block

Real Power. Real Windows.

Looking for powerful electronic design with Windows™ ease-of-use? TangoPRO™ for Windows delivers. We built TangoPRO to exacting Windows standards to ensure familiarity and the shortest learning curve. Others claiming Windows compatibility have merely ported DOS tools, omitting even basic Windows conventions like *drag and drop*.

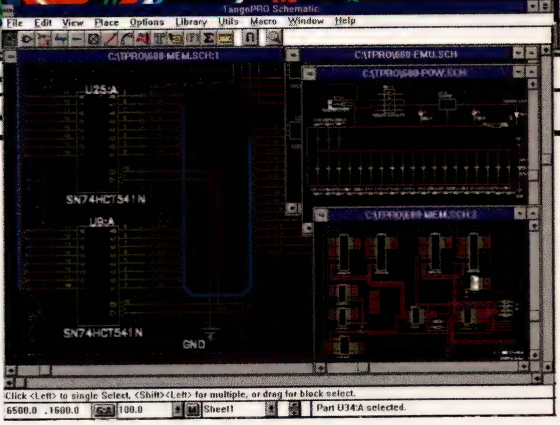
MICROSOFT WINDOWS COMPATIBLE

Hot Features

Easy to use, yet powerful enough to tackle your toughest digital or analog designs. The new TangoPRO for Windows V 2.0 features comprehensive schematic entry and PCB layout with:

■ integrated libraries, ■ hotlinked cross-probing, ■ bi-directional ECOs, ■ 32-bit precision, ■ unlimited design size, ■ curved traces and copper pour, ■ .1-degree rotation, ■ an integrated 100% completion autorouter, and much, much more.

▲ TangoPRO PCB takes on dense through-hole and SMT designs, from $5950.



Click <Left> to single Select, <Shift><Left> for multiple, or drag for block select.

6500.0 , 1600.0 | 100.0 | Sheet1 | Part U34:A selected.

TangoPRO Schematic, ▶ with instantaneous net lists and ERC, $1495.

Free Eval Package

Test drive TangoPRO yourself with our full-function evaluation package, complete with software and tutorial guide.

Call 800 488-0680

Limited Time Competitive Upgrade $189* Order Today

New Lite Versions Now Available

We've tailored versions of TangoPRO Schematic and TangoPRO PCB for less demanding designs and tighter budgets. Get the same great interface and 90% of the features for *one-fifth* the price! Special Limited-time, competitive upgrade prices now available.

Call today for free evaluation software and complete specifications, or to set up a personal sales presentation. Choose TangoPRO for complex designs, or TangoPRO Lite. Both put Real Power and Real Windows to work for you.

TangoPRO™

ACCEL Technologies, Inc.

800 488-0680 – Sales
619 554-1000 – Service
619 554-1019 – Fax

**Competitive upgrade to TangoPRO Schematic Lite, $189, includes OrCAD/SDT file and library translator. Competitive upgrade to TangoPRO PCB Lite, $99 expires December 93. Call for deta*

Extended to 3-31-94!

Charter Member EDAC Electronic Design Automation Companies

CIRCLE 80 FOR U.S. RESPONSE

CIRCLE 81 FOR RESPONSE OUTSIDE THE U.S.

ensures that the correct data versions are used at each step in the process. Also, because a whole design team, and not just one or two people, is now working with the files, quelling problems of concurrent file access becomes a top priority. There also must be a means of defining design configurations and checking them at key steps along the way. The requirement for design data and process management at both the individual and project levels not only prevents errors and speeds product development, but also facilitates communication and coordination among team members.

In the future, engineers may choose to address the process-management problem with an automated tool. For instance, Berkeley Merchant, vice president of Design Environment Services for Mentor Graphics Corp., Wilsonville, Ore., describes a process-management tool that the company's services division created to meet their customers' demands. This tool displays the design flow on the screen *(see the figure).* Design-process steps are visually illustrated, including the data flow. Color-coded icons and a flow chart indicate the project's progress, and arrow heads show the flow of data between tasks. There are two data states—assessment by the provider and assessment by the receiver. By clicking on an icon, users can bring forth the correct tools and data for that part of the design they're interested in. Consequently, wait states are eliminated, and proper data gets to the proper engineer rapidly.

An important part of any process-management tool is the ability to track interdependencies. The software must know what previous steps and files are affected when a change is made late in the design process. Otherwise, all earlier information is outdated.

In the coming years, process management must also address tool development to complete the flow of design automation *(see "How automated is design automation?" p. 84).* In other words, vendors need to create tools for the tedious tasks currently done by hand that fall between functional steps in the design flow. One such example would be a tool that automatically creates a bill of materials between design and manufacturing. Most of this software would be low cost, and would simplify the design flow by filling in holes.☐

HOW VALUABLE?	CIRCLE
HIGHLY	550
MODERATELY	551
SLIGHTLY	552

WE'VE BEEN PROVIDING RF SOLUTIONS FOR LONGER THAN YOU THINK.

RF to Bits™ IC solutions from Tektronix Microelectronics are the answer to your need for smaller, faster, more reliable products. For years, we've been providing precise, cost-effective solutions designing and manufacturing innovative ICs and modules for a wide variety of cellular, spread spectrum, GPS and DBS applications.

From 100 MHz to 5 GHz, we can deliver custom turnkey and customer-designed ASICs and modules with unparalleled speed and precision. Solutions that work to specification the *first* time.

So next RF project, put the **RF to Bits™** advantage to work for you. Call 1-503-627-2515 and make a little history of your own. **Tektronix**

CIRCLE 246 FOR U.S. RESPONSE
CIRCLE 247 FOR RESPONSE OUTSIDE THE U.S.

The "E" Team

Raytheon has teamed with another industry leader, Motorola, to bring Open Architecture, MCM-based SEM E modules to you.

This venture further expands our unique capabilities ... producing a full range of modules... Formats A, B, D and now E, with its enhanced processing capacities for challenging applications in undersea, surface, land-based and avionics systems.

Learn more about Raytheon's uncommon approach to standard electronic modules. Contact the Production Components Marketing Manager at Raytheon Company, Portsmouth, Rhode Island, Telephone 401-842-2055.

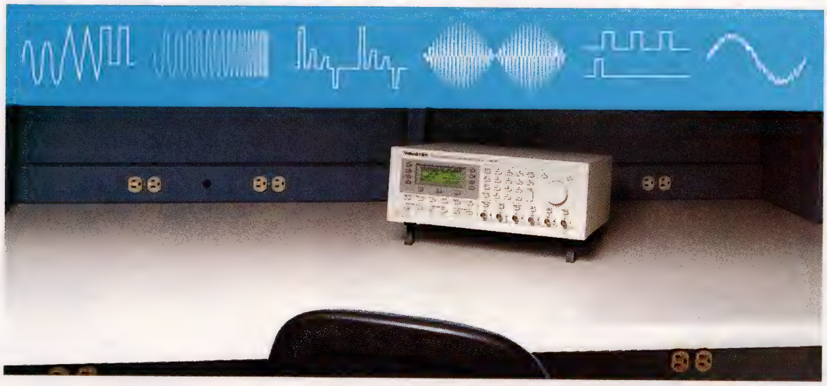
Raytheon

WE THRIVE ON CHALLENGES

CIRCLE 148 FOR U.S. RESPONSE

CIRCLE 149 FOR RESPONSE OUTSIDE THE U.S.

How to Get a Benchful of Signals Without a Bench Full of Generators.



Gone are the days of scouring the lab for function-specific generators.

At a price that's less than many single-purpose generators, Wavetek's new Model 395 does the job of seven different signal sources and does every job extremely well.

In an instant you can choose from a host of signals, from clean sine waves up to 40 MHz to complex pulse trains and arbitrary waveforms. When you use Model 395 as a pulse generator, for example, you can individually control the amplitudes, widths, and rise and fall times for up to ten pulses in a train. On-screen help makes signal selection easier than ever.

You can create many signals that might otherwise require hooking together two, three or more generators. With gating, looping, linking, signal summing, and complete arbitrary waveform capability, our universal signal source can produce just about any waveform you can conceive. You can even store any setup for later use – for recall at the touch of a button!

Take your choice: function generator, sweep generator, pulse generator, modulator, trigger generator, noise generator, arb, and all of the above.

So come to the source for all your signal needs. Call Wavetek today at **1-800-223-9885**, and get all the details on the new Model 395 universal signal source.

The Universal Signal Source.

U.S.A.:(619)279-2200 / U.K.:(603)404824 / Germany:(089)96 09 49-0 / Hong Kong:(852)865-1903

WAVETEK

©1993 Wavetek Corporation

CIRCLE 171 FOR U.S. RESPONSE CIRCLE 172 FOR RESPONSE OUTSIDE THE U.S.

BY SHERRIE VAN TYLE

THE DRIVE TO STREAMLINE SOFTWARE DEVELOPMENT

For the remainder of the decade, software developers will face many of the same challenges that hardware designers are currently grappling with: shorter time to market, a push for higher quality, and a need to hold down costs. Right now, an estimated 90% of software projects are delivered late. What's more, the expense of maintaining software over its lifetime is estimated to be five to eight times its initial development cost. With billions of dollars invested in complex software and ever shorter deadlines for time to market, companies are seeking ways to better reuse, update, and reengineer their existing software.

The drive for maintainability—a term as awkward as some of the spaghetti code inherited by developers—is already changing how software is developed. The need to better maintain software will speed up the application of engineering principles to code development and propel a migration to C++, whose object-orientation lends itself to modularity as well as reuse of code *(see "The migration from C," p. 90).*

"I believe that five years from now, every software developer on their desktop will have a reuse librarian tool that allows them to view things they can use as they're writing and designing their software," says Dave Reed, chief technical officer for Centerline Software, Cambridge, Mass. "So you'll have a debugger, editor, and searcher that allows you to look for things you can reuse. You'll simply specify your requirements."

Reuse of code brings to the fore another critical issue in software development—developer productivity. When software backlogs began adding up to millions of lines of code in the late 1980s, companies looked into how software was developed. For example, many programs for embedded systems were still being written in assembly language because it executes close to the machine level, yet it was (and still is) difficult and time-consuming to debug. However, porting to new processors meant that most of the code had to be rewritten. Because it's processor-specific, assembly code is not modular, and therefore, not reusable. Thus, valuable programmer time is spent rewriting basic functions.

DESIGN TEAMS AIM TO KEEP PACE BY WORKING SMARTER

The next few years will see several trends converge to change how software is developed. One trend involves a new generation of optimizing compilers that will squeeze the most performance out of a processor, freeing developers from optimizing by hand in assembly. This means that developers can work in a higher-level language like C, perhaps writing critical sections in assembly language, and still wind up with code that ports easily to new processors. These optimizing compilers produce compact code, just 5 to 10% larger than comparable assembly code. In developing for embedded and real-time systems, the shrinking costs of memory mean that applications can be written quickly without having to squeeze code into as few kilobytes as possible; the larger program costs a few cents more in memory capacity.

Managing large design teams is another trend that will affect software development in the 1990s. An active area of development is the multiprocessing configuration of digital signal processors. The range of applications will continue to grow, having already extended beyond general digital signal processing to include radar signal processing, control systems, robotics, instrumentation, and multimedia applications that include image and speech processing. Multiprocessing applications, like real-time and embedded applications, typically break down a problem into subproblems, assigning each to a processor.

"As applications become more and more ambitious, developers are going to need help in partitioning tasks among multiple processors," says Tony Agnello, president of Ariel Corp., Highland Park, N.J. (Ariel makes signal-processing and data-acquisition systems based on DSP chips as well as DSP development tools).

Fortunately, the current trend is for tools to handle functions like interprocessor communications so that developers can concentrate on solving issues specific to their applications. For example, a shared-memory interprocessor-support (IPS) pack-

THE MIGRATION FROM C

Software development in the coming years will continue to move toward object orientation. Implemented in a language like C++, object-oriented development promises modular code that's more easily maintained, extensible, flexible, and reusable than software written in other languages. From a developer's viewpoint, C++ offers class libraries and data abstraction features that enhance the development of various software applications and robust tools. Some experts even predict that by the end of the decade, PC-based, object-oriented toolsets will make it possible to create new programs right on the desktop.

In the next few years, though, the compelling reason for moving from C to C++ will likely be C++'s modularity, and thus its reusability: "Programmers think, 'If I write this software once, it will apply to this particular program this time, but there are three other projects that will be able to use this software,' " says Dave Reed, chief technical officer at CenterLine Software, Cambridge, Mass. "C++ is a relatively safe path for programmers who are used to using static languages like C. C++ is based on C and it looks a lot like C. They can learn new functions at their own pace."

However, moving from C to C++ won't be easy or painless during the rest of the 1990s. Developing software that's reusable takes time. Reed emphasizes that managers who aren't willing to allow for time spent upfront will not succeed at integrating reusability into their organizations.

Reed led CenterLine's own C++ project to create ObjectCenter 1.0. A team of C and LISP programmers made a transition to the C++ programming language while developing ObjectCenter, CenterLine's commercial Unix programming environment for C and C++.

The plan, which was to develop ObjectCenter for delivery into the customer's hands in a year, included writing a complete functional specification and a design document. Reed says that the detailed specification saved many wasted development hours. The team decided to use C++ for all development, except when they were modifying existing C code. This approach had the benefits of faster time to market and experience in the language of their target environment. Drawbacks included the unknowns in using C++ as a commercial development language with which few team members had experience; reuse of external code; lack of C++ tools; and reuse of non-object-oriented architectures.

```
/* traverse.c - K&R C version */
void draw_object_list (glist)
struct GraphicList *glist;
{
    while (glist) {
            Graphic* gr = glist->element;
            switch (gr->type) {
            case BOX:
                    draw_box ((struct Box *)gr);
                    break;
            case LINE
                    draw_line ((struct Line *)gr);
                    break;
            }
            glist = glist->next;
    }
}
```

(a)

```
/* traverse - C++ version */
void draw_object_list (glist)
GraphicList *glist;
{
    while (glist) {
            Graphic* gr = glist->element;
            gr->draw();
            glist = glist->next;
    }
}
```

(b)

C++'s modularity means that it can encompass objects written in other languages. As a result, companies that can't afford the time or money to rewrite important applications in C++ will add C++ features, such as class libraries and data abstraction, piece by piece. What's more, like many companies coping with large software projects during the rest of the decade, CenterLine's developers didn't rewrite all of the code. For example, they left all C code in C. As Reed explains, "There is no reason to rewrite base functionality that you can capitalize on because the two languages are link compatible."

Once the developers finished the translation work, they began to write new code using C++ as a procedural language, not as an object-oriented one. The ability to do both ensures an easy transition from C, phasing in adoption of object orientation. Yet if developers forgo using object orientation, they lose out age designed by Tartan, Monroeville, Pa., coordinates Ada programs and tasks within single programs on different processors by means of shared memory. This capability is implemented in Texas Instruments' TMS320C30, C31, and C40 DSP ICs as well as in the Motorola 68xxx family. The processors can be used in any combination.

The package supports interprocessor events and messaging, including interprocessor interrupts, interrupt handlers that recognize events and message arrivals, and user-customizable send and receive data transfers. The software supports local and global event flags with a timeout option. For instance, task suspension and resumption may be tied to local event flags, and global event flags would be visible to tasks not resident on the same processor. Local and global message passing with a timeout option also can be done—task suspension and resumption may be tied to the message queue status. In addition, the program supports static pulses that allow interrupt handlers to signal events and send messages.

Another boon for developers working with multiprocessing and DSP applications is that multiprocessor code-development systems are automatically generating C code that runs up to 30% faster than earlier versions. For example, MultiProx Release 1.2 from Comdisco Systems Inc., Foster City,

on the benefits of modularity.

In the coming years, developers are likely to discover, as did those at CenterLine, a "better C" in C++'s in-line functions, default parameters, reference types, and use of operators like "new" and "delete." Although the developers didn't reap the benefits of C++'s reusability, they noted that C++ is a safer programming language (more static checks in the compilation/link phase); constructs code a little faster (default parameters and reference types); and has better efficiency through liberal use of in-line functions. After six months of using features of C++, the development team began to explore some of the data-abstraction support in C++.

As a programming language, C++ supports the object-oriented paradigm in the key areas of data abstraction, subtyping (or inheritance), and dynamic binding. Data abstraction enables the interface to be separate from the implementation. The separation supplies better modularity between the implementer and user of a type and models the way built-in language types, such as floating-point types, are used. The float type has a well-defined interface (with such operators as +, =, and >) and developers can use this interface without knowledge of the implementation.

"Separating specifications from the implementation of modules will be key to managing large software applications," says Samuel Harbison, director of commercial products at Tartan, which supplies C and Ada development tools for digital signal processors and is based in Monroeville, Pa. Languages with support for data abstraction enables types that are user-defined—a stack type, for instance—to be used in much the same way.

By enabling types to be organized hierarchically, inheritance extends the idea of data abstraction. Types at the top of the hierarchy define general characteristics. Those lower in the hierarchy, which inherit general characteristics, define specialized characteristics.

With dynamic binding, operations can be invoked on an object without realizing the actual type of the object until run time. An example is a list of graphic objects that's to be traversed, with each object being drawn. And if there is no dynamic binding, the programmer must determine the type of each object and invoke the corresponding operation.

In the K&R C (Kernighan & Ritchie C), or ANSI C, example *(see the listing, a)*, the knowledge of what types of graphics objects exist is encoded into one or more switch statements. If a new graphic object, such as "CIRCLE," is introduced, all of the switch statements must be updated. In the C++ version *(see the listing, b)*, only the type and its implementation need definition. This implies that C++'s support for object-oriented programming enables developers to build code that's more maintainable compared with C code.

Over the next few years, debugging in C++ will remain problematic. Reed notes that although C++ has come a long way, the language and supporting compilers aren't as stable as those for C. Although a committee (X3J16) has been working on a proposed standard for C++, CenterLine doesn't expect it to be approved before 1998. X3J16 is weighing enhancements to the language, such as run-time type information, while low-level language issues must be resolved before agreement is reached on a standard. With a fluid language definition and a growing feature set, Reed explains, developers having to write for multiple platforms will suffer the most from lack of a standard C++ because compilers and debuggers may not support all the features.

For organizations that don't have teams of programmers well-versed in C++, PARTS (parts assembly and reuse tools), developed by Digitalk Inc., Los Angeles, Calif., enables developers to assemble and reuse mainframe-based software components in icon-based environments like Macintosh System 7, OS/2, and Windows.

The PARTS toolset enables developers to assemble software components written in Smalltalk/V, Cobol, C, and other languages. The company also is responsible for Smalltalk/V, the latest version of an object-oriented language that had its origins in the early 1970s at the Xerox Research Center in Palo Alto, Calif. (PARC).

Calif., automatically creates multiple programs from a single digital-signal-processing algorithm optimized to run on multiple processors. The processors are represented as a block diagram in Comdisco's DSP Framework design environment *(see the figure)*. The system generates, compiles, and downloads code to the target system for each of the processors.

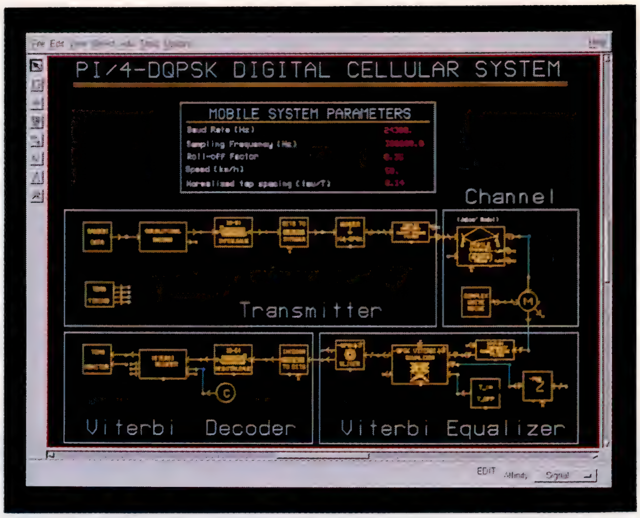
Furthermore, all of the necessary interprocessor communications are completed automatically. Because designers are freed from these tedious tasks, they can explore "what-if" scenarios to optimize the design. The code-development system supports Motorola's DSP96002 and TI's C30 and C40 floating-point processors as well as processor development boards from Ariel and others. Developers can work on any combination of Unix workstations, a network of supported processors that can communicate by Unix sockets, or a single workstation linked to an IBM PC AT-compatible computer containing multiple development boards.

SIGNAL-FLOW ANALYSIS

The '90s also will see more built-in code-analysis features in development environments. For instance, C code generation in Comdisco's MultiProx upgrade was enhanced by adding a signal-flow analysis feature that improves code sequencing as well as schemes that minimize static variables and group conditional statements in the source code. Code generated in the MultiProx 1.2 runs 10 to 30% faster than code generated by the earlier release. Designs created in the workstation-based DSP Framework use interconnected icons to form signal-flow diagrams that incorporate fast Fourier transforms, filters, modulators, channels, and similar functions.

A design can be simulated, analyzed, and fine-tuned using the DSP Framework and then partitioned by simply drawing rectangles around functions to be executed on separate processors. Designers can easily move function blocks between partitioned regions and delete or redraw regions to optimize the implementation.

Developers will get more help in the next few years from robust environments that span development, debugging, and run time. For example, new tools have been introduced for Analog Devices' ADSP-21060 Super Harvard Architecture Computer (SHARC) digital signal processor. Release 3.0 ASDP210xx development software includes an instruction-level simulator, assembler, linker, C compiler, and C run-time library. The C compiler supports Numerical C and includes C language extensions for vector and matrix operations used in DSP algorithms. The Norwood, Mass., company claims these extensions supply greater code efficiency and a more natural syntax for developing DSP applications with fewer lines of code. The tools are available for IBM PCs and compatibles, and for Sun workstations.



Represented as a block diagram, a digital signal-processing design for a digital cellular system is segmented to run on multiple processors. With MultiProx 1.2 from Comdisco's DSP Framework environment, designs are partitioned automatically by drawing rectangles around functions to be executed on separate processors.

DSP developers also can look to the Virtuoso software environment that runs on the ADSP-21060 as well as the C30, C31, and TMS320C40 and other processors. This parallel-processing operating system is based on a proprietary second-generation real-time kernel built around a nanokernel—a pared-down microkernel—featuring a context switch (or task switch) time of less than 1 μs (on the TMS320C40 DSP IC).

MULTILEVEL APPROACH

Virtuoso's designer, Intelligent Systems International NV, Linden, Belgium, takes a multilevel tack in the programming environment. Typically, programming tools must handle timing constraints in microseconds, which means programming in an assembler at the interrupt level. That effectively rules out a modular approach to building a multitasking application. Real-time multitasking kernels, on the other hand, provide for modularity but impose an unacceptable overhead for handling fast interrupts at the task level. By building around a fast nanokernel, Virtuoso enables a developer to program critical code at desired performance levels while retaining the benefits of the other levels. Internally, the kernel manages the processor context as a resource, swapping and restoring the minimum of registers needed.

At level 1 (ISR0), for instance, interrupts typically are accepted solely from hardware. Interrupts need only be disabled during ISR0, which can be less than 1 μs on a TMS320C40. The developer can handle the interrupt completely at this level or pass it on to level 2 (ISR1), the light task level, or the C task level. As a result, data can be sampled in burst mode at more than 1 Msample/s on a TI C40 DSP IC. At ISR1, a trap from ISR0 invokes ISR1, which handles the interrupt with global interrupts enabled. Level 3 (ISR2), the nanokernel level, con-

Now Showing on Screens Everywhere!

HTBasic 4.0 With HP BASIC Compatibility

rom first-run premieres of your newest programs to reruns of your avorite HP Basic programs, **TransEra HTBasic 4.0** will make you star performer.

his newest version of High Tech BASIC from TransEra runs not nly on **IBM PCs** but now on **Sun SPARCstations**, as well as the ewest **HP 700 PA-RISC** Workstations.

nd HTBasic 4.0 is now compatible with the latest version of **P BASIC 6.2**, including full support for **TRANSFER**. Utilities re included that directly read HP LIF format diskettes for both rogram and data files making platform switching as easy as hanging channels.

ut cross-platform compatibility is just the beginning. You won't nd a better engineering tool for your **technical, graphical, athematical, scientific, laboratory, data acquisition**, or **nstrumentation** applications.

HTBasic has the most extensive *built-in* support for **GPIB, GPIO** and **data acquisition cards** from companies like **HP, IOtech, Keithley/Metrabyte, Data Translation**, and **National Instruments**, not to mention ***TransEra's*** own line of outstanding plug-in cards.

If you're a current HTB user, you'll want to upgrade right away. And if you haven't yet discovered the ease and power of **TransEra's HTBasic 4.0**, you're in for a very pleasant surprise.

So if you want to make a good showing with your next application design, get **TransEra HTBasic 4.0**. It's the best investment you can make. Call now for information.

801-224-6550

TransEra
345 EAST 800 SOUTH, OREM, UTAH 84058
TEL: 801-224-6550 FAX: 801-224-0355

CIRCLE 218 FOR U.S. RESPONSE

CIRCLE 219 FOR RESPONSE OUTSIDE THE U.S.

sists of tasks with a reduced context, delivering a task switch of less than 1 μs on a TI C40 chip. Three types of primitives are available for synchronization and communication. Each light task starts up and finishes as an assembly routine, can call C functions, and leaves the interrupts enabled. The full application can be written at this level.

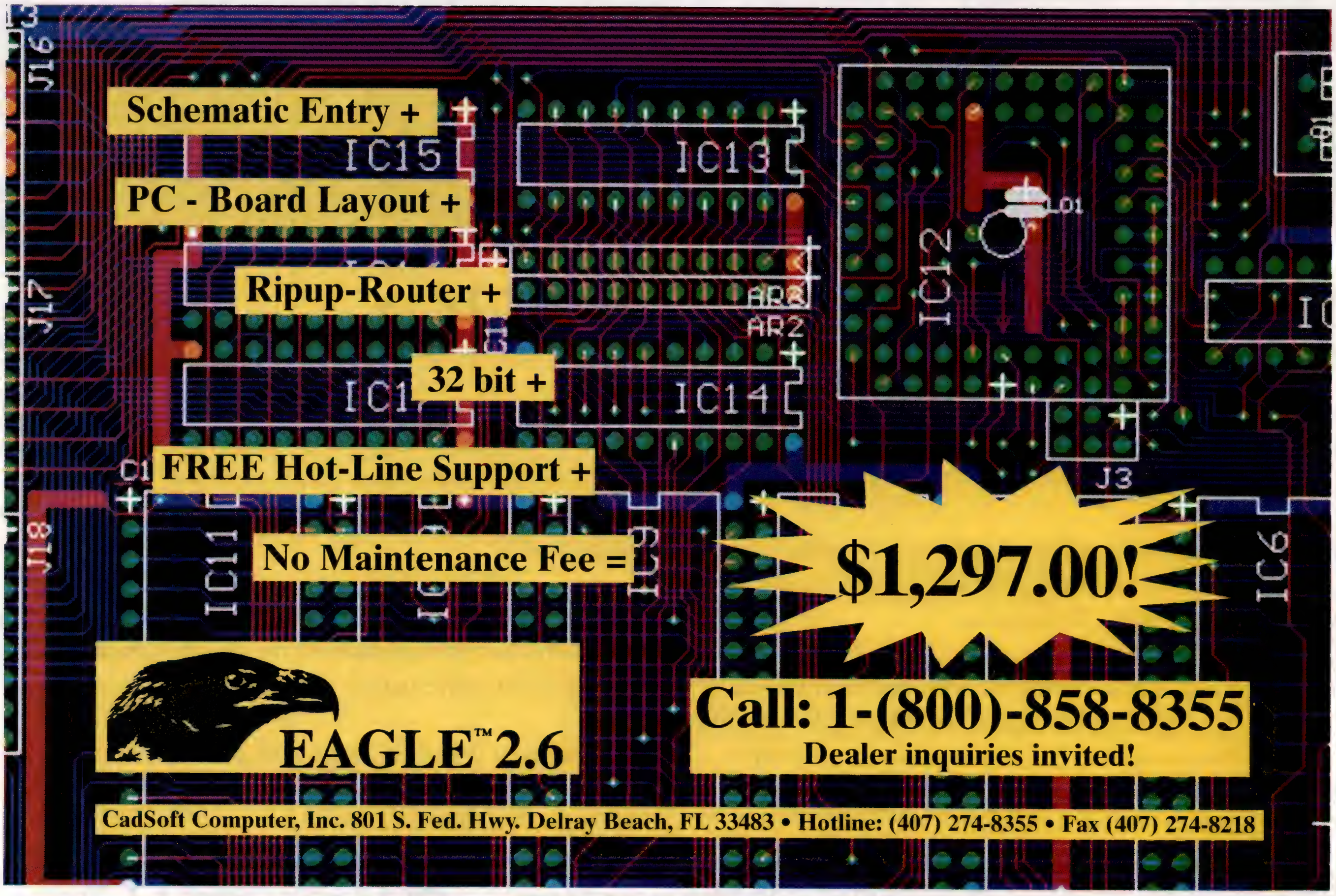
REMOTE DEBUGGING

Also aimed at helping developers working with DSP applications, a remote Ethernet debugging system (REDS) created by Spectrum Signal Processing makes possible development in C and source-level debugging of code from Sun workstations. The REDS package consists of a Debug Gateway board and client/server software. Spectrum (located in Burnaby, B.C., Canada) has a unique program number for the REDS server. As a result, the server can be added to Ready Systems' VxWorks customers who already have a 680x0 board with a VxWorks development license. With REDS, several host Sun computers, each running multiple copies of Texas Instruments' debugging tools, can debug remote VME chassis. These contain multiple TMS320C40 DSP boards in a client/server application. Using standard remote procedure calls (RPCs), REDS can coexist with other Ethernet applications. With Ethernet, the host and target DSP system can be separated by almost any distance. Other debugging configurations, such as VME-embedded Sparc boards or workstations with an integral VMEbus, are supported by Spectrum.

SIGNAL PROCESSING LIBRARY

To relieve designers of the task of optimizing critical sections of code, DSPLib from Spectrum supplies hand-optimized C-callable assemble routines for functions critical to peak performance. The library, designed by Ensigma, a U.K.-based research and development specialist, can implement a 100-coefficient finite impulse response (FIR) filter in 548 μs on a 40-MHz C40 processor, one-sixth the execution time of a compiled C routine. The library supplies infinite impulse response (IIR) filters, fast Fourier transforms, convolution, correlation, and windowing functions, along with routines such as Gaussian white noise generation and matrix multiplication.☐

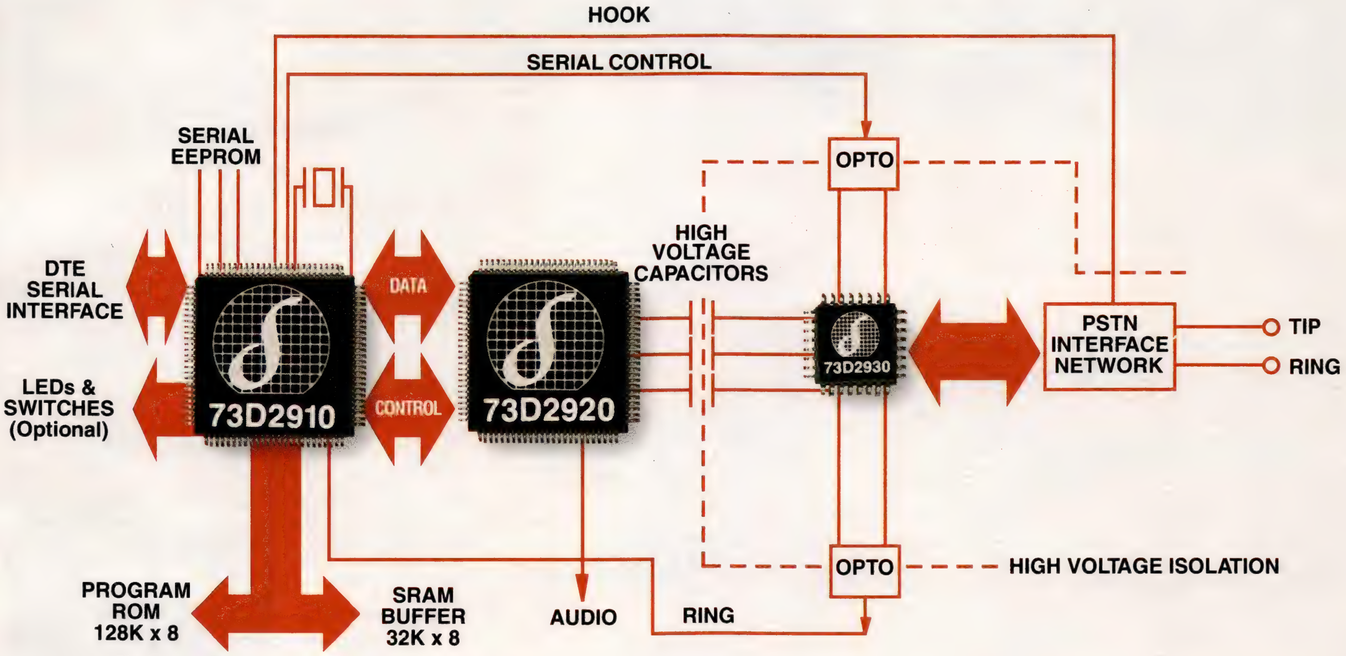
HOW VALUABLE?	CIRCLE
HIGHLY	560
MODERATELY	561
SLIGHTLY	562


Schematic Entry +
PC - Board Layout +
Ripup-Router +
32 bit +
FREE Hot-Line Support +
No Maintenance Fee =
$1,297.00!
EAGLE™ 2.6
Call: 1-(800)-858-8355
Dealer inquiries invited!
CadSoft Computer, Inc. 801 S. Fed. Hwy. Delray Beach, FL 33483 • Hotline: (407) 274-8355 • Fax (407) 274-8218

CIRCLE 98 FOR U.S. RESPONSE
CIRCLE 99 FOR RESPONSE OUTSIDE THE U.S.

Ultra Low Power Voice Modem ICs

Plans are set for future talks.



These are plans you can act on now. Or when you're ready. They involve our new, and dare we say, breakthrough ultra low power 2950 Data/Fax Modem IC with optional speech compression capability.

Our 2950T version features TrueSpeech™ audio compression adopted by Microsoft® for voice-capable PCs, and brings that capability to laptops, notebooks, PDAs and other low power hosts.

So now embedded voice files can accompany modem/fax transmissions and answering machine functions from portables without taxing storage space. To wit, a one-minute voice file that used to eat up 900 kilobytes now needs just 60 kB.

Even if your design isn't yet of such vocal proportions, you'd be wise to consider our 2950 data/fax solution. It saves you cost, design space and transmission time while offering silicon "transformerless" DAA operation. Plus, it runs on ultra low power for both 3.3V and 5V worlds. It offers both QFP and TQFP packaging. And it's universally customizable. It does everything but speak like the 2950T.

Which is exactly why you should be talking with us. Call and we'll send you literature package **CPD-16** and, if you'd like, we'll tell you how to contact your nearest Silicon Systems representative. **1-800-624-8999, ext. 151.**

Silicon Systems, Inc.
Communications Products Division
14351 Myford Road, Tustin, CA 92680
Ph (714) 573-6000 Fax (714) 573-6906
European Hdq. U.K.
Ph (44) 81-443-7061 Fax (44) 81-443-7022

silicon systems®
A TDK Group Company

TrueSpeech™ is a Trademark of DSP Group, Inc. Registered trademarks are property of their respective owners.

Circle 187

SIGNAL INTEGRITY HEADACHES?

Crosstalk increases dramatically as signal speeds rise.

Courtesy of Motorola, Austin

**Crosstalk – Ground bounce – Parasitics – HEADACHES!
As designs get faster, the headache only gets worse.**

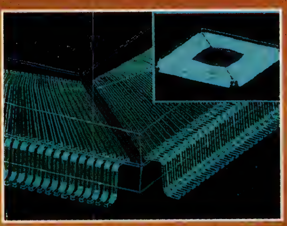
Ansoft has the cure.

1 Proven 3D Extraction

Your designs include packaging, power and ground planes, and multi-layer components – all complicated 3D structures. And nobody does 3D like Ansoft. The 3D field solvers in Maxwell® Spicelink are built on decades of engineering experience and guaranteed correct, accurate answers.

2 Inductance & Non-Ideal Grounds

At clock speeds above 50MHz, inductive effects – such as "ground bounce" – can cripple board, MCM, and package designs. Maxwell offers a proven method of characterizing non-ideal grounds and loop inductance – not partial inductance–so that you KNOW what is happening in your design.



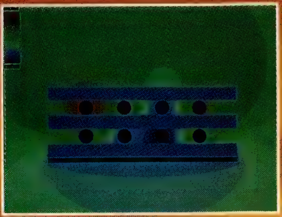
Courtesy of NCR Microelectronics

3 Choice of Extraction Methods

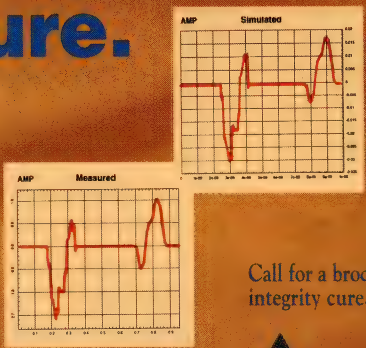
Maxwell gives you all the extraction you need in a single program. Use our fast finite element technology for resistance and inductance calculations, multipole accelerated boundary elements for capacitance calculations, or 2D transmission line or planar simulators for simpler structures.

4 SPICE-Level Accuracy

Maxwell Spicelink combines SPICE-level accuracy with accelerated run times on interconnect models. Built-in accelerator for commercial SPICE allows interconnect to be modeled in existing SPICE environments.



Courtesy of AMP Interconnect Systems



5 Experience

Developing genuine cures for signal integrity problems is not easy – others have tried. Join the hundreds of engineers already using our tools to cure their design headaches.

Call for a brochure on Maxwell Spicelink: the signal integrity cure. Or you can take two aspirin...again.

ANSOFT

Ansoft Corporation
Four Station Square Suite 660
Pittsburgh, PA 15219 USA
Telephone: 412-261-3200
Fax: 412-471-9427
Internet: info@ansoft.com

The companies and products named are trademarks of their manufacturers.

CIRCLE 90 FOR U.S. RESPONSE **CIRCLE 91 FOR RESPONSE OUTSIDE THE U.S.**

The top 10 reasons to give U.S. Savings Bonds:

10 They don't require batteries. **9** No assembly required. **8** They don't need to be tried on. **7** You can send them anywhere without having to pack them in big, brown boxes filled with . **6** They only come in one color. **5** They're available in 8 denominations. **4** Even if they already have one, they'll certainly appreciate another. **3** They make you look like a bigger spender than you really are. **2** They won't be out of style before they arrive. **1** People ALWAYS remember the people who give them Savings Bonds. Thank You

Go to your BANK, buy a , ask for a gift certificate – and be remembered.

Take Stock in America U.S. SAVINGS BONDS

A public service of this magazine

Interpoint's MIL-STD-883 dc-dc converters:

Recognized for outstanding performance.

On Space Station Freedom, the Patriot Missile, European Fighter Aircraft and thousands of critical applications, Interpoint dc-dc converters are the ones designers choose first. However you measure performance, Interpoint commands the field.

HI-REL DC-DC Converters for Every Power Level

Series	V in	V out	Outputs	Power
MSA	16 to 40	5,12,15	1 or 2	5 W
MHF+	16 to 40	5,12,15	1 or 2	15 W
MTR	16 to 40	5,12,15	1, 2, or 3	30 W
MFL	16 to 40 80 to 160 160 to 400	5,12,15,28	1 or 2	65 W*
MFLHP	19 to 40	5,12,15	1 or 2	100 W*

** Multiple units current share*

Interpoint is recognized for broadest selection. From fully qualified SMD parts to low-cost solutions, from 5 to 285 watts. Interpoint has a solution for almost every power need.

Interpoint is recognized for innovation. Our 20-year history of breakthroughs includes the first 70 W/in³ board-mountable dc-dc converters.

Interpoint is recognized for reliability. Our power supplies have logged more than 1,000,000 field hours per failure.

Our new, fully compliant MSA Series offers 5 watts of power in a case just 0.27" high. The MSA also meets MIL-STD-704A input voltages (up to 80V surges) with 5, 12, and 15 Vdc outputs.

CIRCLE 275 FOR U.S. RESPONSE

CIRCLE 276 FOR RESPONSE OUTSIDE THE U.S.

For your **FREE HI-REL DESIGN FIELD KIT,** with Guides to selecting and using dc-dc converters in HI-REL systems, call:

1-800-822-8782

In Europe, call:
Interpoint U.K. (0252) 815511
Interpoint France (1) 34-28-54-55

NEW!
The 5-watt
MSA Series
now meets
MIL-STD-883

interpoint

ADVANCED ICs WILL UNCORK COMMUNICATIONS BOTTLENECKS

FUTURE DATACOM AND TELECOM SYSTEMS NEED HIGH-SPEED, LOW-POWER ICs TO MEET DEMAND FOR BANDWIDTH, PORTABILITY.

STEVEN J. SHARP
Steven J. Sharp, chairman, president, and chief executive officer of TriQuint Semiconductor, Santa Clara, Calif., holds a BS in mechanical engineering from Southern Methodist University, Dallas, Texas, an MS in engineering science from the California Institute of Technology in Pasadena, and an MBA from Stanford University, Calif.

Recent computer and communications developments have created a dramatic surge in demands for bandwidth to carry the huge amount of data generated by today's computers. Computer power is quadrupling every three years, memory size is doubling every two years, and the number of pixels per screen is increasing 50% annually. At the same time, video and graphics processing requirements are driving transmission speeds higher. And the trend toward portability has prompted the development of small, lightweight systems with longer battery life. These waves of change, though, are challenging IC developers to produce the high-speed and low-power-consumption devices that will enable tomorrow's communications systems.

Future systems will move away from traditional parallel data-communication schemes toward serial communications, with its promise of lower cost, smaller form factors, and the elimination of skew. Although serial communications require much higher data rates than parallel configurations, the pieces are now coming together to enable widespread use of high-speed serial data communications. Standards for high-speed links like the Enterprise System Interconnect (ESCON) and the Fibre Channel are being finalized and implemented. Fibre Channel, which is supported by a broad spectrum of semiconductor, adapter, and system manufacturers, defines serial communications up to 1.0625 Gbits/s. Manufacturers of high-performance ICs, such as TriQuint Semiconductor, have introduced cost-effective transmitter/receiver/support chip sets that implement these new standards.

Fibre Channel data can transmitted at 266 Mbits/s over copper for distances up to 50 meters. The costs of optical components and fiber-optic cable declined dramatically in 1993, making long-distance transmission much more affordable. In 1994, fiber-based 266-Mbit/s adapter cards will most likely cost under $500, and 1-Gbit/s cards will be available in 1995 for under $1000.

Demand for high-speed networking is being sparked by new-generation graphical-user-interface-(GUI)-based operating systems on high-performance workstations and servers that generate and transmit multi-megabyte files. Similarly, telecommunications is experiencing much greater demand for bandwidth over the public network. Data from faxes, WAN servers, and new video applications has pushed telecom beyond what can be handled by T-1 and T-3 rates (1.5 Mbits/s and 45 Mbits/s) on copper. These forces play to the strengths of communications chips implemented in gallium arsenide (GaAs). High-speed GaAs physical-layer interface ICs began enabling new high-speed plateaus for fiber-optic telecom in 1986. Today, that high-speed plateau is at 2.5-Gbit/s data rates with the Synchronous Optical Network (SONET), which is being served in high volumes with available GaAs technology.

When asynchronous transfer mode (ATM) proliferates to the desktop with data rates of 52 Mbits/s and 155 Mbits/s, that will generate even higher demands on the network. ATM is creating a demand for a new type of equipment: the premises switch. Designers of switching systems will learn that it's difficult to push switch bandwidths much above 2 Gbits/s. However, today's crosspoint switch techniques extend the bandwidth of a switch to 24 Gbits/s. The push will continue on the line card as well. Multichip implementations of 622 Mbits/s through 2.5 Gbits/s are being reduced to single-chip devices with on-board independent phase-locked loops for the transmit clock and receive clock recovery.

Gallium arsenide has attained a position of commercialized maturity from a pricing, reliability, and packaging perspective. Its low power consumption and low noise at higher frequencies make it an enabling technology for many wireless applications, such as portable computers and instruments with fax/modem capability, cellular telephones, satellite communications, local-area networks (LANs), cable TV, and personal communicators. By the year 2000, most data, both of the voice and digital variety, will be transmitted in a wireless mode.☐

DIGITAL TELEPHONY WILL ENABLE THE INFORMATION SUPERHIGHWAY

DIGITAL MODEM CHIPSETS ARE ECONOMICAL SOLUTIONS FOR CONNECTING TO TODAY'S HIGH-SPEED TELECOM NETWORKS.

David Chase
David Chase is the director of wide area networking products at Level One Communications, Inc. Folsom, Calif. He attended the University of Michigan and Wayne State University.

An insatiable appetite on the part of datacom users for increased bandwidth is driving the evolution of digital telecom equipment and service markets at unprecedented rates. An increasing number of users are now discovering that low-cost, increasingly-available digital services, such as Switched 56, Switched 384, T1, and the Integrated Services Digital Network (ISDN), are alternatives to maturing analog modem technology for such high-bandwidth applications as video conferencing, telecommuting, and enterprise networking. However, the timing and selection of the longer-term communication "pipes" into our homes and businesses still has to be debated and, perhaps, hybridized over the next five years. As a result, the market will use existing digital services (with their increasingly ubiquitous deployment and low cost-per-bit of transmitted data) as "on ramps and off ramps" to the emerging Information SuperHighway.

As this demand for digital services increases, and the need for lower-cost equipment solutions intensifies, digital modem chipsets will emerge as one of the key enabling technologies for the Information SuperHighway. These chipsets will closely resemble their analog predecessors. Integrated, single-, or two-chip "front ends" will be controlled by RISC microcontrollers equipped with high-speed, buffered serial ports. Standard AT command interfaces will ease compatibility with the installed base of PC and workstation communications software. Features such as error correction and data compression will further entice consumers by improving performance as well as lowering transmission costs.

In the end, transmission costs will drive both the market and the winning technology. Today, users with SW56 modems can reliably transmit information at up to 200 kbits/s (compressed) for under 25 cents per minute (Los Angeles to New York), while business-quality videoconferencing (using two SW56 lines) can be accomplished coast to coast for as little as 50 cents per minute.

Such chipsets must be compatible with the currently deployed and tariffed digital services: SW56, SW384, SWT1, and ISDN. Only SW56 is widely available today in the U.S., although other services, including ISDN, should be in general use by 1995. Because these are dial-up switched services, as opposed to leased line offerings, users only pay for their connection time. Unlike noisy analog POTS (plain old telephone service) lines, these digital offerings have typical guaranteed error rates of better than 1 in 10^6. The emergence of competing services, such as the High-Rate Digital Subscriber Line (HDSL), the Asymmetric Digital Subscriber Line (ADSL), and hybrid cable/fiber—all offering video-dial-tone capability—will further increase the sophistication and deployment of next-generation chipset technologies.

Looking back, the growth of the analog modem market during the 80's was fueled both by lower costs/higher integration as well as consumer and business needs for dial-up data capability. Compuserve, Prodigy, private and corporate BBS's, and the emergence of telecommuting all contributed to the success of the analog market.

Similarly, digital modems will also have their driving applications—particularly for business—such as Videoconferencing, Teleconferencing, Multimedia, Educational Services, Image Retrieval, Publishing, CAD, CAE, CASE, Medical Data, and local-area-network (LAN) Internetworking. Also, the next generation of consumer applications will tightly couple digital communications technology with multimedia, HDTV, and cable products.

One thing is clear: As the Information SuperHighway matures, the wide area network (WAN) will begin to resemble the LAN, and users will require "payload processing"—efficiently "packed" data and easily implemented addressing techniques.

Users will soon see the benefits from the enabling technology of digital modem chipsets in a wide variety of services and applications. Indeed, as some pundits suggest, consumers may soon order pizza direct from their living-room TV!☐

N-TIME DELIVERY IS A MUST
HOW MUCH WILL THIS COST?
RANSISTORS,
UALITY! QUALITY! QUALITY!
ARLINGTON,
WHAT KIND OF LEAD TIME CAN I EXPECT?
, CSA, SETI, SEMKO, DEMKO, VDE, BABT
RIAC DRIVER,
Roland Dahlquist
GIC OUTPUT DEVICES
WHAT ABOUT GLOBAL REGULATORY APPROVALS?

Thinking Optoisolators? We know what's on your mind.

There's a lot to consider when you're considering the need to incorporate optoisolation components in your applications. Like selection, quality, cost, delivery, and global qualification. But rest your brain–Motorola takes the guesswork out.

Above all you may be wondering–can Motorola supply what you need when you need it? The answer is–ABSOLUTELY! Not only have we substantially increased our entire optoisolator capacity, we've decreased our leadtimes and improved our on-time delivery record. Most of our popular standard 6-pin and many of our 8-pin optoisolators have a four-week leadtime.

Name It–We've Got It!

Selection? Motorola's optoisolator line includes a broad selection of transistor, darlington, triac driver and logic output devices. And new devices are being added all the time, including our newly introduced 600V random phase 6-pin triac driver, and the new 600V zero cross triac driver.

And of course, whatever the device, you can be sure it's the best we can make it, because we continually strive to deliver defect-free products and services that meet all the requirements of our customers. Just ask one!

Global Regulatory Approvals

If you're concerned about the marketability of your products worldwide–and what customer isn't? –you'll appreciate Motorola's complete range of optoisolator global approvals, including UL, CSA, SETI, SEMKO, DEMKO and BABT, as well as VDE-approved standard 0884/8.87.

Keep Motorola Top-of-Mind!

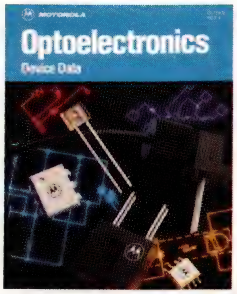
Thinking optoisolation? Think Motorola! We'll work with you to provide the best possible product choices for your applications.

For more information on our broad line of opto products, request our Optoelectronic Device Data Book or World Class 6-pin Optoisolator brochure by sending the coupon below or by writing Motorola Ltd., European Literature Centre, 88 Tanners Drive, Blakelands, Milton Keynes MK14-5BP, United Kingdom.

MOTOROLA

Motorola and Ⓜ are registered trademarks of Motorola Inc.

To: EUROPE: Motorola Ltd., European Literature Centre, 88 Tanners Drive,
Blakelands, Milton Keynes MK14-5BP, United Kingdom

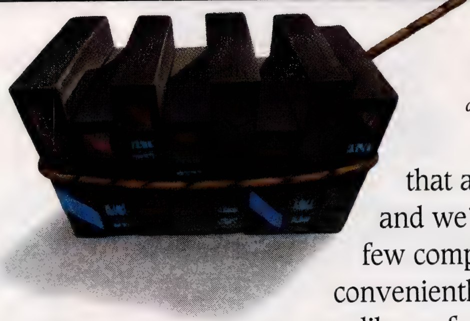


☐ *Please send me Optoelectronic Device Data Book #DL118/D, Rev. 4.*
☐ *Please send me World Class 6-pin Optoisolator Brochure #BR1201/D.*

627ED011094

Name
Title
Company
Address
City
Country

WE HAVE A VERY SERIOUS IMAGE PROBLEM. TOO MANY OF YOU KNOW WHO WE ARE.



We're one of the few companies to round up one library for both gate arrays and standard cell ICs.

Recently, people like yourself were asked to list the ASIC vendors they know of, and then jot down a few things about them.

In somewhat of a surprise, one company was mentioned just about as often as its considerably larger competition.

Little old AMI.

However, every silver lining has a cloud. Because "little and old," it turns out, is precisely how many of you described us.

And because of that, a step behind.

Now, "little" we can take. (After all, we're by no means the biggest ASIC vendor.)

And "old," well, in an industry where corporate life spans are commonly measured in terms of months, AMI's 27 years can seem, well, rather antiquated.

But a step behind!

Now that's an image problem we're going to take issue with right here and now.

Fact is our 0.8 micron technology is about the fastest you'll find, and it's characterized all the way down to 2.5 volts. What's more, we build digital gate arrays and standard cell ICs that are without equal, and we're one of the few companies that conveniently features one library for both.

In addition to digital ASICs, AMI also carries mixed-signal ASICs and standard products, plus our very own software for FPGA to ASIC conversion and mixed-signal design.

And finally, thanks to the services we offer and the uniquely personal way we do business, this "old-growth ASIC vendor," as one of you so kindly put it, has the most loyal customers in the industry.

Now we understand that all this may come as a big surprise. So to help you over your shock, we've prepared some materials just loaded with information on AMI.

The real AMI.

To learn more, give us a call at (208) 234-6789.

Though we're a long way from the Silicon Valley, blueprints for our digital and mixed-signal ASICs are readily available.

We're counting on our 0.8 micron ASIC process to leave a lasting impression.

AMI® SEMICONDUCTORS

American Microsystems, Inc.
2300 Buckskin Road, Pocatello, ID 83201

Copyright © 1993, American Microsystems, Inc. All rights reserved.

Circle 82 For Literature (US Response)
Circle 83 For Literature (Response Outside US)

NEW TECHNOLOGIES ENABLE PARALLEL COMPUTING

CHOOSING THE CORRECT PROGRAMMING MODEL IS A KEY TO AN EFFICIENT PARALLEL-COMPUTING ENVIRONMENT.

The industry is currently experiencing what amounts to a parallel-computing explosion. From massively parallel supercomputers to multiprocessor embedded systems, new designs employing multiple CPUs are proliferating. To utilize these new and innovative parallel architectures, engineers are confronting challenges in both hardware and software design. Several emerging technologies address these needs.

One major challenge facing users of any parallel-computing environment is choosing a programming model. Today's popular programming languages like C and Fortran were designed for uniprocessor machines that execute a single thread of code. When applied to a multiprocessor computer, these languages are awkward at best. Fortunately, this situation is now improving.

Based on research done with special-purpose parallel-programming languages, parallel-programming features are now beginning to appear in C and Fortran. Fortran 90, for example, contains data types and statements that allow entire vectors and arrays to be manipulated directly.

One domain that requires more research is in debugging and performance tuning. While several parallel debuggers and performance-monitoring tools have popped up in the marketplace, few standards exist in this area. Hardware support in the form of time-stamp registers and event counters are essential to obtain good results.

For such software initiatives to be successful, the hardware design of the parallel computer must be carefully executed. Three considerations are of paramount importance here: sufficient memory bandwidth for all processors; global shared-memory addressing; and rapid processor synchronization.

Most modern RISC microprocessors provide a mechanism for hardware cache coherency, usually based on the MESI protocol. MESI stands for the four states assumed by a cache line—Modified, Exclusive, Shared, or Invalid. Consequently, multiple microprocessors can be tied to one memory, and a consistent view of that memory can be seen.

However, when more than a few microprocessors are tied together in this manner, there's not enough memory bandwidth available to keep them all busy. New cache-coherency techniques based on directories, which are now just emerging, allow multiple banks of memory to be kept consistent. One such design is Sky Computer's Parallel Compute Cluster. This cache-coherent shared-memory architecture provides a wide memory bandwidth as well as hardware barrier-register synchronization.

In this design, four processors, each with its own cache memory, are connected to four memory banks with directories via a crossbar network. A uniform memory-access procedure lets all processors have equal access to all banks of memory. This simplifies the programming task because data can be placed in any bank and then operated on by any processor—with no loss in performance.

Memory consistency is maintained by the directories associated with each memory bank. These directories keep track of which processors, if any, have cached copies of the memory locations in that bank.

In addition, hardware barrier registers are included so that the computer and the operating system can synchronize the operation of various processors rapidly without affecting memory bandwidth. These hardware features, together with an advanced multiprocessor operating system and an optimizing parallel compiler, can provide efficient and transparent parallel computing.

For larger processor groups, a message-passing network connects the processing nodes. This network might have a grid, a hypercube, or a tree topology. Recent advances in serial-bus technology have made such networks easier to construct. TAXI, Fibre Channel, and the new Autobahn Spanceiver chip sets permit the construction of inexpensive high-performance processor-to-processor interconnects. Some digital signal processors are appearing with serial or narrow parallel communications facilities built into the chip. Examples include the TI TMS320C40 and the Analog Devices ADSP 21060.☐

ROBERT HOENIG
Rober Hoenig is the vice president of engineering at Sky Computers Inc. He holds a Bachelors of Science degree in Physics and a Masters of Science in Computer Science from Rensselaer Polytechnic Institute.

SINGLE-BOARD COMPUTERS WILL REQUIRE DESIGN MAXIMIZATION

FACING GREATER CHALLENGES, ENGINEERS WILL ADOPT MODULAR DESIGN APPROACHES USING ASICs AND MEZZANINES.

JERRY GIPPER
Jerry Gipper, director of VME components marketing for the Motorola Computer Group, Tempe, Ariz., holds a BSCE degree from Iowa State University, Ames, and a MSCE degree from San Jose State University, Calif.

Today's pc-board designers are coming up against tremendous challenges when trying to keep ahead of, let alone keep up with, the rapid changes occurring in the pc-board arena. Meeting these challenges requires a new way of thinking, a new way of keeping up. Recently, novel solutions and innovations that address board-design problems encountered during the past decade have started to appear.

Modern 32-bit single-board computers (SBCs) are high-performance machines that require development cycles and time-to-market spans of a few months. Developing these complex-design SBCs has become quite expensive, however. As a result, it's very important that the design be utilized to its fullest. Manufacturers are meeting this need with design elements that can be added to the board through population options or expansion-mezzanine modules. Modular design approaches employing ASICs and mezzanines like IndustryPacks, SBus, and memory modules are increasingly being used to reduce costs and decrease time to market. For example, these subsystems eliminate the need to redesign the main board to accommodate a new DRAM package or capacity.

Such modular design efforts will accelerate as the semiconductor industry continues to shift its fabrication lines to high-volume parts, combined with the varying life-cycle lengths of board components. Today's changing life-cycle lengths for components makes it difficult to manage designs over a life cycle of more than 18 months. Currently, DRAM life cycles are under three years and microprocessors are less than two—with both continually getting shorter. Because products are still being designed with 5- to 10-year life cycles with shorter life-cycle components, it's mandatory that designs are able to mature with the evolving technology.

The Peripheral Component Interconnect (PCI) is expected to be embraced by SBC hardware vendors in various products, from small embedded controllers to workstations and servers, because using PCI-specified components shortens the time to implement peripheral chips on new designs. Extending PCI to a mezzanine form factor will also allow functionality to be easily added or changed.

Today's mezzanine buses can increase I/O capacity, application flexibility, and, significantly, peripheral functionality. Common peripherals, such as Ethernet, SCSI, or graphics, will be designed on the main board. Multiple, additional, or custom peripherals will occupy the mezzanine slots. New board designs will even use mezzanines for the microprocessor. This will allow migration to faster microprocessors.

As VMEbus enters its second decade, various performance enhancements are inspiring the board-design community to develop and evaluate new proposals to keep VMEbus at the forefront of computer-bus technology. Enhancements and proposals to the bus specification, including Multiplexed Block Transfers (MBLTs), Source Synchronous Block Transfers (SSBLTs), and the Autobahn protocol for serial transfers over lines reserved for serial buses on the VMEbus P1 connector, have established VMEbus as a well-maintained and robust technology. Future VMEbus enhancements will include increased use of serial bus solutions, thus making it possible to implement optical technology. This technology will support data transfers well beyond 1 Gbyte/s. Soon, 64-Mbit DRAMs will begin being sampled and tested on board designs, and as a result, single-board memory densities on VME form factors will reach 1 Gbyte in capacity. With 64-bit DRAM densities, designers will be challenged on how to handle capacities that are beyond the addressing capability of microprocessors with 32-bit address lines.

More and more RISC microprocessor architectures will be used in SBCs as time wears on. The emergence of the PowerPC will put pressure on existing RISC architectures, such as SPARC and MIPS, and the DEC Alpha and Hewlett-Packard PA processors will turn on the heat a little more. In addition, RISC-based machines are reaching shipping volumes that will only intensify the RISC versus CISC battle.☐

FUTURE TEST SYSTEMS WILL USE STANDARD NETWORK PROTOCOLS

TEST AND MEASUREMENT TASKS WILL BE HANDLED BY THE SYSTEM ELEMENTS THAT PERFORM THEM BEST.

Facing increased pressure to cut project development times, reduce R&D costs, and improve product quality, design engineers are now insisting on better instrument systems. Tomorrow's solutions—performing the same basic functions but using fundamentally different architectures—will ease the job of verifying the performance of critical circuits and systems, while also minimizing wasted time.

For example, distributed computing, data communications, networking, and information management systems are achieving huge performance gains. Combining advances in measurement, computation, and communications (a concept we call MC^2 at HP) offers new solutions in many traditional and new markets. To realize this potential, test and measurement system standards and designs must keep pace.

Unfortunately, current general-purpose computers can't control instruments because instrument communication protocols like IEEE-488 (GPIB/HP-IB) aren't standard computer communication protocols. Nor can T&M systems excel at processing test data, because the best and fastest data-processing programs are those for general-purpose computers. Therefore, engineers would benefit a great deal from measurement system enhancements that build on computer technology. One straightforward way to obtain this leverage is a multiprocessing architecture in which one CPU is dedicated to real-time measurement and control tasks, while a second runs a popular operating system, such as Unix or Windows.

A promising new concept—the measurement server—takes multiprocessing to a higher level. Just as a print server offloads the mechanics of printing from a general-purpose computer, a measurement server would offload measurement and control functions. Measurement tasks and computational tasks would be executed on the parts of a LAN-based system best suited to perform them.

Measurement servers, whether internal to standalone instruments or systems or contained in separate controllers, could act as nodes on the network, using standard computer protocols. They could function at remote locations, performing a range of measurement tasks on command, storing raw or preprocessed data, and returning information on request. To make the measurement-server concept economical, instrument-to-LAN connectivity must be standardized by building on the best software standards from among the many available. The implementation must serve enough applications to support a standard that will eventually be embraced by multiple T&M manufacturers.

One approach would be to build a LAN-connectivity software toolkit based on standard LAN services like TCP/IP, remote procedure calls, and so on. If an application compiled on a PC, workstation, or mainframe contained measurement procedures, those procedures could be downloaded into the measurement server's real-time environment, and then called remotely when needed. The main computer in such a networked system would be reserved for various traditional computer activities, including developing code, downloading and uploading programs and data, making procedure calls, and processing and displaying data.

The use of measurement servers will grow as they become increasingly "friendly" to engineers who aren't experienced system programmers. To make instrument bus protocols transparent to the user, languages such as Basic and HP VEE could be used to perform measurement functions. Enhanced LAN connectivity software could allow system engineers to partition tasks without having to learn the details of networking.

Concurrent engineering, shorter product life cycles, more complex products, and higher quality goals will require more complex and pervasive test systems spanning corporate-wide across design and manufacturing. If implemented with measurement servers and built on standardized networking protocols, engineers (everyone on the team, worldwide) will control these systems from their own computers. The result will be enhanced design productivity and effectiveness.☐

NED BARNHOLT
Ned Barnholt, vice president and general manager of Hewlett-Packard's Test and Measurement organization, Santa Clara, Calif., received his BSEE and MSEE from Stanford University, Calif.

FLUIDIC TRANSISTORS WILL CHANGE THE FACE OF DATA ACQUISITION

ELECTRO-FLUIDIC INTEGRATED CIRCUITS ARE PAVING THE WAY FOR CHEMICAL MICROPROCESSORS.

MARK ZDEBLICK
Mark Zdeblick, chief technical officer and founder of Redwood Microsystems Inc., Menlo Park, Calif., received B.S. degrees in architecture and civil engineering from the University of Illinois at Urbana. He received MS degrees in aeronautical and astronautical engineering and a PhD in electrical engineering from Stanford University, Calif.

There was a time when all computation was performed mechanically—first with an abacus, later with an adding machine. The integration of multiple transistors on a single substrate fundamentally and irreversibly altered the way number-crunching machines were designed and used. Similarly, many chemical analyses and syntheses today are performed by carrying test tubes, vials, and trays from one piece of specialized equipment to the next.

The latest development in this genre is a device called the fluidic transistor. It can be integrated on an electronic substrate, enabling true electro-fluidic integrated circuits (EFICs). When combined with sensors and electronic components, EFICs will revolutionize data acquisition by allowing many chemical analyses to be performed on a reprogrammable chemical-analysis manifold.

The fluidic transistor will make possible the chemical microprocessor—a device that can be reconfigured to automatically perform many different chemical analyses or syntheses. Just as an electronic microprocessor contains a memory, arithmetic logic unit, and I/O areas, a chemical microprocessor will incorporate functional blocks with names like reagent multiplexing, reaction stages, sample handling, separation, and detection. Initially, these blocks will be built separately and integrated as part of a large electro-fluidic multichip module (EF MCM). Later they will be further miniaturized and integrated on a single substrate. Simple EF MCMs have already been built and will soon be commercially available (ELECTRONIC DESIGN, *Nov. 1, 1993, p. 34)*.

For example, Redwood Microsystems recently introduced a credit-card-size EF MCM that electronically regulates pressure. At its core is a Fluistor, which is a valve made using semiconductor manufacturing techniques. This device—capable of controlling 0-100 psi with 1% accuracy—will make data-acquisition systems more interactive. The small size of the EF MCM and the ease in integrating fluidic components with electronic ones will result in portable, wireless devices that mechanically and chemically interact with their environment.

Chemical microprocessors will lead to small, portable instruments that allow on-site monitoring of various phenomena. These instruments will sample and analyze in one step. For instance, researchers are trying to measure the chemical makeup of the ocean to better understand how it functions.

So far, they've been able to come up with a device that can be placed on the ocean bottom to continuously measure one chemical concentration at that location over a period of time. But to measure other chemicals, they would need additional machines set up for those chemicals.

In the future, chemical microprocessors will be used in making a device that can measure a number of different chemicals in sequence and then shut down for a period of time to conserve reagents. Such a component would be small and cheap enough so that several instruments could be placed in the same location at different depths using a tether. Wireless communications would enable remotely situated buoys to communicate with on-shore researchers on the other side of the world. Alternatively, researchers could drag these instruments from one spot to another to generate a three-dimensional map of each of the chemical concentrations of interest.

In addition, the FBI could use a portable data-acquisition and analysis system that can chemically compare two samples—one from the crime scene and the other from a suspect. Today, the Bureau must send these samples to a lab in Virginia and wait a week for the results. Imagine a device that can perform simple genetic analyses on site. Once this chemical information is translated into electronic information, wireless systems could electronically enter it into a national database.

Electro-fluidic microprocessors will extend the reach of data-acquisition systems into the chemo/fluidic realm. Allowing even more fluent communication between a computer and its surroundings, EF MCMs will find application in areas that today seem to border on science fiction or are beyond the imagination.☐

The Electronics Industry Is Changing, And So Is Electro International.

Electro®/94
International

May 10-12, 1994
Hynes Convention Center
Boston, MA

World Class Engineering
For The 21st Century

TECHNOLOGY... EDUCATION ... APPLICATIONS

Electro International is changing. Recognizing the growth and upswing of the electronics industry, Electro's conference program along with an expanded show floor will deliver a comprehensive industry event for the latest in electronics products and information. If you are responsible and accountable for making technology based decisions, and you need to save money and time, then you need to be at ELECTRO.

TECHNICAL KNOWLEDGE ... SOLUTION BASED IDEAS

This year's technical conference program offers managers and engineers real world solutions to the latest technologies and techniques. The program will consist of many mini-conferences exploring new trends and technologies and issues defining today's electronics marketplace. Four days of tutorials, papers, and industry roundtables explore new trends and technology and exchange ideas on topics including:

Manufacturing Technologies Conference covers contract manufacturing, advanced packaging, test, design, PCB, semiconductor and mfg processes.
Business Conference covers international business, distribution issues, purchasing, critical market issues and negotiations.
Software for Engineering Conference covers development tools, standards, CASE, Re-engineering.
Emerging Technologies Conference covers HDTV, neural networks, fuzzy logic, biomedical engineering, telecommunications networks and 64 Bit computing.
Career Development & Education Conference covers job opportunities, career development, retraining.

PRODUCT DEMONSTRATIONS ... THE LATEST ADVANCES

If you're looking to choose the best solution for your design problems, you need to know all your options. The new floor at ELECTRO offers you those options and more. It has expanded to include all key areas of electronics. Over 700 exhibits will showcase products within the components, software engineering, design and test, SMT, contracting manufacturing, PCB, and workstations arena.

If you are a circuit designer, system designer, package designer, research and development engineer, testing specialist, purchasing, personnel, engineering management, a hardware or software engineer, or a corporate executive with a critical need to know the most current developments for electronic product design and manufacturing, you need to be at ELECTRO International.

ELECTRO International is sponsored and produced by
IEEE and eia

Please send me more information on:
☐ attending ☐ exhibiting

I am looking for more information on the following:
☐ components
☐ design and test
☐ contracting manufacturing
☐ workstations
☐ software engineering
☐ SMT
☐ PCB
☐ business/marketing

Name: __________
Title: __________
Company: __________
Address: __________
City, State, Zip: __________
Phone: ( ) __________ Fax: ( ) __________

PLEASE FAX TO (214) 385-9003

ELECTRO INTERNATIONAL is managed by Miller Freeman, Inc., 13760 Noel Road, Suite 500, Dallas, TX 75240-4332

ED

CIRCLE 126 FOR U.S. RESPONSE CIRCLE 127 FOR RESPONSE OUTSIDE THE U.S.

POWER SUPPLIES' FUTURE DEPENDS ON COMPONENTS AND ASSEMBLY

EVEN AS TOPOLOGY ISSUES SETTLE OUT, QUANTUM LEAPS IN COMPONENTS AND PSMT TECHNOLOGY ARE NEEDED TO MOVE AHEAD.

PHIL KOETSCH
Phil Koetsch, senior vice president at Computer Products Inc., South Boston, Mass., is responsible for coordinating the company's worldwide engineering activities. Koetsch holds BSEE and MSEE degrees from the University of South Carolina, Columbia.

The dominant technology advance in power supplies today is the move toward higher frequency. Although the benefits of higher switching frequencies are well known, the tools, components, and know-how to implement successful designs have evolved slowly.

A big step forward has come from the design community's general acknowledgement that zero-voltage switching (ZVS) is more effective in managing power MOSFETs than zero-current switching, an early high-frequency technology. ZVS is a type of resonant topology, but is classified as "transition-resonant." That is, only the switching transition resonates using the energy stored in the parasitic components.

Components have changed little of late, and nothing revolutionary looms on the horizon. But component technology has enabled many earlier advances in power supplies, so it pays to track what's happening:

- *MOSFETs* opened the door to higher-frequency power supplies, but progress toward better and less costly devices has been slow. MOSFETs use silicon poorly, a fact dictated by device physics. The resulting large die size makes lower costs hard to come by.
- *Diodes* continue to limit the efficiency of low-voltage supplies, and they create a major circuit problem in high-voltage supplies. Either the forward drop, the reverse recovery, or the parasitic capacitance conspire to challenge the power-supply designer. Until new semiconductor substrates like silicon carbide or diamond are in use, only a breakthrough in rectifier technology will help.
- *Capacitors* show signs of cost reductions that support the high-frequency trend. Large multilayer ceramic capacitors, once found only in military applications, are becoming less costly as their commercial use increases. A similar price trend is likely with tantalum capacitors.
- *Ferrites and power cores* have improved. Still, transformers and inductors are a major obstacle to very-high-frequency operation. Parasitic elements, such as leakage inductance, winding capacitance, and skin and proximity effects, make it very difficult to design high-frequency magnetics. For this reason, it seems likely that commercial switching frequencies will be limited to about 1 MHz in the next five years.

A survey of operating frequencies in use today would show that most supplies switch at 100 kHz or less. Much work still needs to be done to exploit the improved capabilities of component and design technology and move this average frequency substantially higher.

One manufacturing technology with an impact on power supplies, and especially dc-dc converters, is thermally conductive substrates. Such substrates form the mechanical platform for applying assembly automation to those heat-dissipating components that historically have been manually inserted. The advantage is improved quality with reduced size and cost. The end result is a form of surface-mount technology that can be termed power surface-mount technology (PSMT).

SMT is now the preferred assembly method for many types of electronic equipment. But typical power supplies, with their extreme thermal constraints and bulky energy-storage components, have at best mixed SMT with a healthy number of through-hole components. Thermally conductive substrates promise more highly integral, lower-cost assembly. Such substrates and the required assembly technologies are now in development. Ultimately, they will lower the cost of dc-dc converters enough to make distributed-power architectures attractive for large systems.

This is only the first step, because distributed power requires the combination of a front-end supply and dc-dc converters—and that combination must compete with centralized power. The competitive difference will come principally from manufacturing technology, not from design technology.

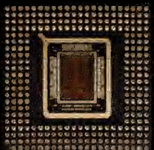
As dc-dc converters change, there will be an eventual impact on ac-dc supplies. One can expect to see PSMT concepts applied to low-power ac-dc products within the next five years.☐

The author wishes to acknowledge the contributions of John Bassett.

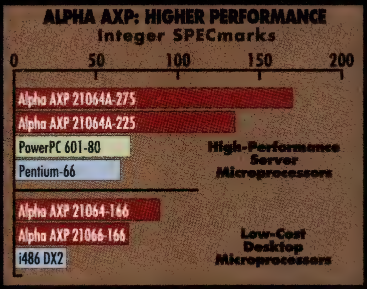
You Can Play Around With Windows NT On Another Microprocessor.

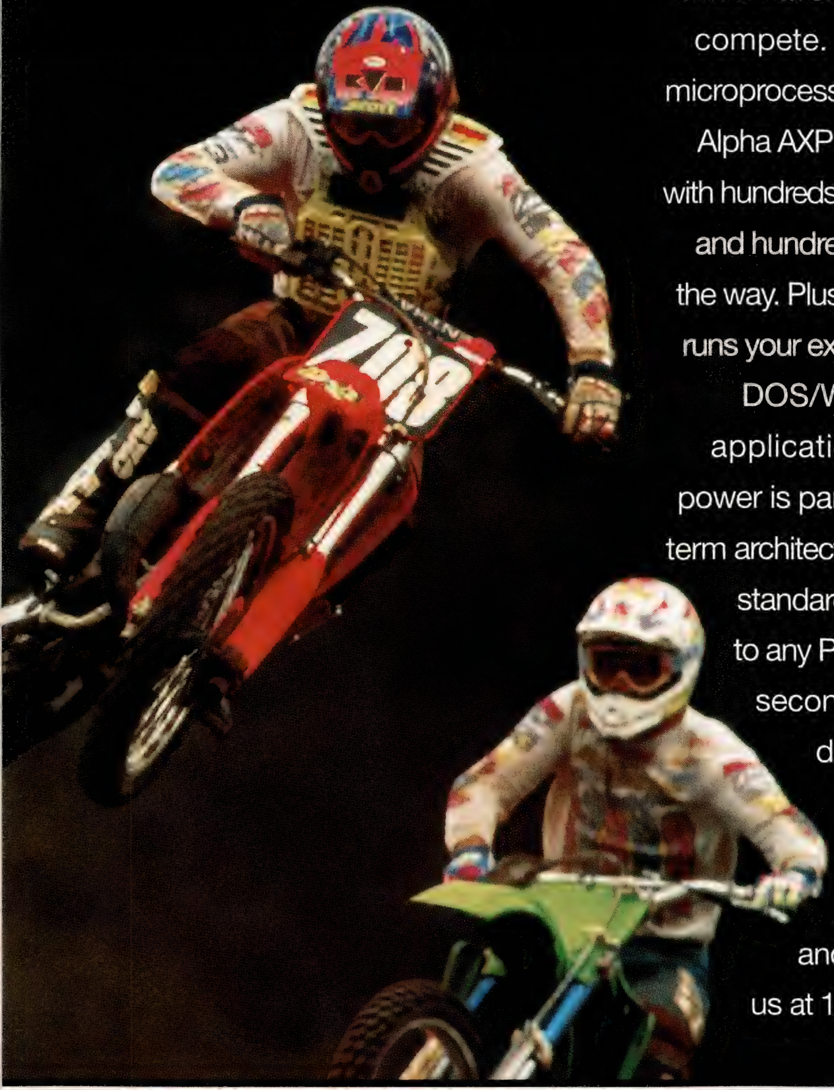
©Digital Equipment Corporation, 1994. The DIGITAL Logo and Alpha AXP are trademarks of Digital Equipment Corporation. Windows and Windows NT are trademarks of Microsoft Corporation. i486 and Pentium are trademarks of Intel Corporation. PowerPC is a trademark of IBM.

Now Imagine Letting It Fly. Alpha AXP Does It Now.



You're going to blaze some new trails with the mainframe power of Windows NT.™ Don't compromise it. Run it on the fastest vehicle you can get– an Alpha AXP™ microprocessor. Choose from a family of fast server microprocessors with performance as high as 170 SPECInt, more than twice that of Pentium™ or PowerPC™ – and priced to compete. Or choose from low-cost desktop PC microprocessors with prices that start below an i486.™ Alpha AXP runs Windows NT with thundering speed, with hundreds of Windows NT applications shipping now and hundreds more on the way. Plus Alpha AXP runs your existing 16-bit DOS/Windows™ applications. All this power is part of a long-term architecture based on a scalable RISC design and standards like the PCI local bus. And it's available to any PC maker–from us now, and soon from our second source Mitsubishi Electric Corp. The decision with Windows NT is simple. On other microprocessors, it runs. On Alpha AXP, it flies. Which way would you rather cover new ground? Call your PC maker and ask about the Alpha AXP family. Or call us at 1-800-332-2717. And kick start your future.





To Work

digital™

CIRCLE 104 FOR U.S. RESPONSE

CIRCLE 105 FOR RESPONSE OUTSIDE THE U.S.

PASSIVE COMPONENTS WILL IMPROVE AS THEY CONTINUE TO SHRINK

FURTHER MINIATURIZATION IS IN STORE FOR CHIP COMPONENTS, WHOSE MATURATION PROCESS ISN'T AS COMPLETE AS IT SEEMS.

AL KIRWAN
Al Kirwan, vice president and director of discrete components at Rohm Corp., Antioch, Tenn., earned a BSEE from Auburn University, Auburn, Ala.

Trends in passive chip components for the foreseeable future will be driven by customer demands for overall improved characteristics, including tighter tolerances, smaller sizes, and broader value ranges—at lower prices. Another trend is the growing relationship between the supplier and customer. Component manufacturers can no longer rely only on the latest technology to win a coveted place in a customer's approved vendor list. Issues involving pricing, just-in-time delivery, and electronic data interchange (EDI) will also play major roles in the decision-making process.

Miniaturization continues to be a key factor in chip resistor and capacitor technology. The desire to reduce the size of circuit boards or to increase the functions within the same board space remains a driving force. As a result, chip sizes have gone from the 1206 size (3.1 by 1.55 mm) down to the current 0402 size (1.0 by 0.5 mm) for resistors, and the 0603 size (1.55 by 0.8 mm) for capacitors. The move to smaller sizes is progressing so quickly that equipment manufacturers are preparing for even smaller products. Sizes as small as 0202 (0.5 by 0.5 mm) are on the horizon for resistors, but such dimensions limit applications for capacitors.

Just two years ago, chip products in the 0402 size were so unusual that placement equipment for them was unavailable. The challenge of placing parts at these extremely small sizes is significant, but equipment manufacturers responded quickly with placement-head modifications as an interim solution. New equipment was eventually created to place small chips. Nevertheless, as components progressively shrink in size, new designs will need to be balanced against placement capabilities.

Another trend is the development of single-package, multiple-element products that include resistor and capacitor combinations. Widespread use of these passive networks, as well as more sophisticated multi-function modules, will be the design direction of the future. However, designers may need to consider the cost-to-performance ratios much more closely. Multi-function modules can pack a great deal into a smaller space, but probably at a higher cost. One example might be an array of capacitors with resistors screened onto exterior surfaces and then terminated. Currently, transistor arrays—sometimes called "digital" transistors—are integrating up to four resistive elements into the SOT package. More complex combinations will certainly follow.

Performance improvements will continue to be required of passive components by design engineers. The present 5% and 1% thick-film resistor tolerances will be driven toward 0.5% and lower, bordering on the tolerances attainable with thin-film technology. Also, tighter temperature-coefficient characteristics over broader resistor-value ranges and operating temperatures will be in greater demand. In addition, high-temperature applications are on the rise—requirements of 170°C are now reaching 200°C or more. On top of that, higher power ratings beyond the current 2-W levels are targeted as future goals of many users.

New issues to be addressed in chip capacitors include improved high-frequency operation, higher capacitance per unit area, and the replacement of tantalums with ceramics having equal impedances at lower capacitance values. Capabilities among capacitor manufacturers are improving, but new production techniques and better materials and procedures will bring only incremental gains. However, a new breakthrough will occasionally appear. Recently, sputtered-end terminations (instead of dipped) markedly increased the usable capacitance area on each part.

Quality and reliability concerns, once relegated only to product integrity, are being monitored over the entire manufacturing-to-delivery process. Adherence to total quality management (TQM) and ISO9000 processes are becoming necessities.

Passive-component technology is often viewed as an unchanging, simple world of mature commodity products. In reality, it is dynamic and rapidly evolving to meet users' demands of a lot more for a lot less.☐

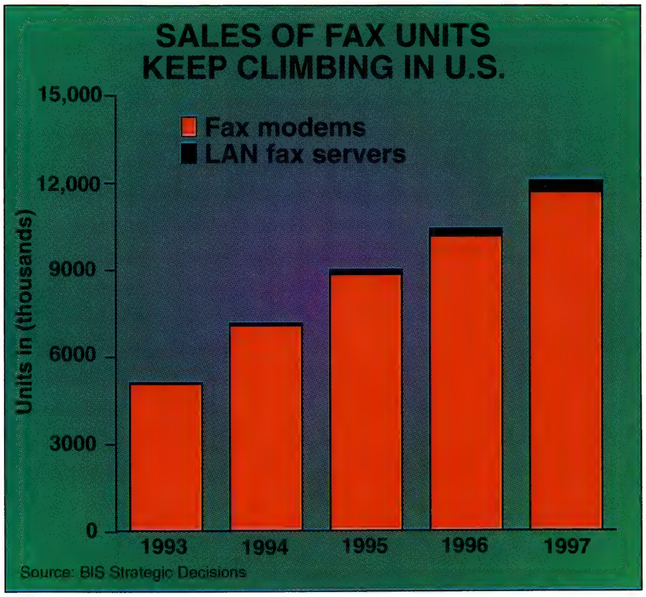
ELECTRONIC DESIGN QUICKLOOK

EDITED BY SHERRIE VAN TYLE

MARKET FACTS

Sales of facsimile units of all types are booming, increasing 138% from 5.1 million units this year to 12.1 million units by 1997, according to BIS Strategic Decisions. Internal and external modems, which make up most of unit sales, will increase to 11.6 million units by 1997.

Driving the market are widespread price cuts, fax integration of data and voice, a burgeoning mobile computer market, and the desktop PC emerging as a communication center, explains Janet Fugazotto, senior market analyst for the Norwell, Mass.'s Image Communication Systems market requirements service. Fugazotto also points to price cuts on 14.4-kbit/s fax modems that are spurring upgrade sales and pushing prices down on low-end products. As a result, fax modems are becoming more affordable to new users as well as low enough in cost for vendors to preinstall in portable and desktop computers. Meanwhile, the PCMCIA card is making it easier to add fax capability to mobile computers, especially personal digital assistants (PDAs), she notes. Another growing area is that for local-area-network (LAN) fax server systems. Sales increased 125% from 1992 to 1993.


SALES OF FAX UNITS KEEP CLIMBING IN U.S.

Source: BIS Strategic Decisions

TIPS ON INVESTING

With companies downsizing, more and more engineers are turning to self-employment as engineering consultants. Let's look at a benefit geared to small businesses—a retirement savings program that has been around for several years: the simplified employee pension (SEP) plan, which features special advantages for the company and the employee.

While your employer sets up the SEP, you direct the investments. Your employer makes contributions on your behalf, although the law allows a company to suspend contribution. All contributions grow tax deferred. You may continue to invest up to $2,000 separately in your IRA while also participating in an SEP. You may place IRA and SEP money in the same investment, which could make tracking your retirement assets easier and may save you money in account maintenance fees.

With an SEP, you have a wider range of investment choices than those offered by most other company-sponsored investment plans. You may invest in the stocks, bonds, mutual funds, annuities, unit trusts and other securities of your choice. However, that also means you have to do more homework on which investments are best for you. A financial consultant can help you select investments suitable for your goals and style of investing.

If your plan is a salary reduction SEP, you may contribute your own money through automatic payroll deduction. This type of SEP also lowers your taxable income for the current year.

For the employer, an SEP offers tax benefits, flexibility and easy administration. As an employer, you can deduct all company contributions made on behalf of your employees from your taxes. You have until your company's tax filing date to establish and fund the plan. You must contribute the same percentage of compensation for each participant. In addition, as a profit sharing plan, you are free to suspend contributions in times when business is poor.

Because the employee directs the investments, your fiduciary responsibility is limited. There are minimal administrative responsibilities regarding each employee's investments, as long as you meet a few disclosure requirements. There is no need to file IRS Form 5500.

Using a program offered by an investment firm could make things even easier. You would write only one check for all participants, designating how money should be credited to each account. Also, your employees could take advantage of the firm's products, services and investment expertise.

Combined employee and employer contributions may be up to 15% of the employee's income, to an annual maximum of $30,000. This limit will be reduced to $22,500 by the 1993 federal budget act.

Henry Wiesel, a financial consultant and qualified pension coordinator with Smith Barney Shearson, can be reached at Smith Barney Shearson, 1040 Broad Street, Shrewsbury, NJ 07702; (800) 631-2221.

ORE!

nversion without the NRE.

TOSHIBA

ALTERNATE SOURCE FOR XILINX FIRST IN SERVICE

AMI

ALTERNATE SOURCE FOR ACTEL FIRST IN SERVICE

Slash your per unit cost on FPGA and gate arrays.

Whether you're converting your FPGA designs into affordable ICs, or looking for a second source for your gate arrays, Encore! is a surprisingly affordable answer.

In only a few weeks, Orbit turns your netlists into prototypes and production quantities. So you can cut your per-unit cost very quickly. Or quickly find an alternate source for production of your gate arrays.

- Convert FPGA netlists
- Convert gate array netlists for alternate source
- Get prototypes in as little as three weeks
- Get your choice of packaging options
- Move quickly into full-scale production

For more information on converting your FPGAs and gate arrays with no NRE contact Encore! Technical Sales. (800) 331-4617. In California (800) 647-0222. Phone (408) 744-1800. FAX: (408) 747-1263

ORBIT SEMICONDUCTOR, INC.

Second Source, First in Service

CIRCLE 244 FOR U.S. RESPONSE
CIRCLE 245 FOR RESPONSE OUTSIDE THE U.S.

Altera, Xilinx, Actel, VLSI Technology, LSI Logic, NCR, AMI, Toshiba and AMD Mach are registered trademarks of their respective companies.

ENC

FPGA or Gate Array Co

ALTERNATE SOURCE! FIRST IN SERVICE FOR ALTERA PLD'S

VLSI TECHNOLOGY

NCR

LARGE SCALE LSI LOGIC INTEGRATION

AMD MACH

No NRE lets you convert small quantities — even as low as 100 chips.

No NRE means converting FPGAs can make economic sense at quantities under 100 chips. And with our fast-turnarounds on prototypes and production quantities, you can start cutting your per-unit cost immediately.

Gate array users can also affordably meet a sudden demand for product by quickly — and inexpensively — developing an alternate production source.

With Encore!

- No NRE - just fast paybacks
- Cut your per-unit cost on runs as low as 100 chips
- Call Orbit for an easy economic analysis

Encore Base	**44**	**68**	**84**	**100**	**144**	**176**	**208**
# of Gates	**660**	**2,000**	**4,000**	**6,000**	**14,000**	**22,000**	**32,000**
Packages	44 PLCC	68 PLCC	84 PLCC	100 PQFP	144 PQFP	160 PQFP	208 PQFP
	28 PLCC	44 PLCC	68 PLCC	84 PLCC	100 PQFP	144 PQFP	160 PQFP
PLCC	20 SOIC	28 PLCC	44 PLCC	68 PLCC	84 PLCC	100 PQFP	144 PQFP
PQFP	16 SOIC	20 SOIC	28 PLCC	44 PLCC	68 PLCC	84 PLCC	100 PQFP
SOIC					44 PLCC	68 PLCC	84 PLCC
						44 PLCC	68 PLCC

A wide range of packages are available to Encore! users.

How does Orbit slash per-unit cost on quantities as low as 100 pieces?

QUICKLOOK

BEST SELLERS

What are the best-selling electronics and computer science books?

ELECTRONICS

1. *Art of Electronics,* 2nd ed. by Paul Horowitz and Winfield Hill. Cambridge University Press, 1990. $59.95.
2. *Art of Electronics Student Manual* by Paul Horowitz. $27.95.
3. *JPEG Still Image Data Compression* by William Pennebaker. Van Nostrand Reinhold, $59.95.
4. *User's Guide to Vacuum Technology, 2nd ed.* by John O'Hanlon. John Wiley & Sons, $59.95.
5. *Discrete Time Signal Processing* by Alan V. Oppenheim & Ronald W. Schafer. Prentice-Hall, 1991. $65.

COMPUTER SCIENCE

1. *Object-oriented Technology: A Manager's Guide* by David Taylor. Addison-Wesley, 1991. $20.50.
2. *Software Configuration Management* by Steve Ayer. McGraw-Hill, 1992. $45.
3. *Computer Organization and Design* by David Patterson. Morgan Kaufman, 1993. $64.95.
4. *Mythical Mammoth,* Frederick Brooks. Addison-Wesley, $24.75.
5. *Software Testing Requirements* by Borix Beizer. Van Nostrand Reinhold, 1991. $52.95.

This list is compiled for *Electronic Design* by Stacey's Bookstore, 219 University Ave., Palo Alto, CA 94301; (415) 326-0681; fax -0693.

HOT PC PRODUCTS

TransferPro enables Unix systems to read and write Windows, DOS, and Macintosh information, operating seven times faster than Sun's PC NFS. Operations include copying, moving, deleting, renaming, creating, and removing files and directories. TransferPro has versions for Sun Microsystems Solaris 2.1 and Silicon Graphics–Motif.

In addition, the program transfers files to SCSI devices like Bernoulli and Syquest drives, magneto optical drives, and removable hard disk drives. Both single-user versions list for $349; a single-user floating license goes for $849. For more information, contact Digital Instrumentation Technology, 127 Eastgate Drive, Suite 20500, Los Alamos, NM 87544. CIRCLE 460

CMFiler Version 5.36c is an update to a shareware disk/file manager for DOS. The idea is to ease organizing disks transparently using mnemonic, one-touch commands. It works as a DOS application in a Microsoft Windows environment or as an OS/2 DOS box. A tree module enables users to display disk structures side by side and copy, delete, or move entire directories.

The file manager's tree services include a fast filename finder and text finder. The results of searches or the tree structure itself can be printed. As shareware, CMFiler has a registration fee of $30. For more information, contact NoVaSoft, 3239 Riverview Dr., Triangle, VA 22172-1421; (703) 221-1833 or -1471; CompuServe 72130,1400. CIRCLE 461

OFFERS YOU CAN'T REFUSE

Engineers can discover the advantages of programmable logic firsthand with a free design kit and device sample from Altera. The FirstStep kit consists of design utility software and a voucher for a free sample of the company's EPM7032 EPLD (erasable programmable logic device). FirstStep is Windows-based software that compiles a design and then generates a programming file. Combined with the engineer's programming hardware, the kit has everything needed to create a finished EPLD design. The kit is available by calling Altera Corp., 2610 Orchard Pkwy., San Jose, CA 95134-2020; (800) 289-7032. *LM* CIRCLE 465

Now you can get Spice models that more accurately predict large signal behavior of high performance signal conditioning products like op amps, AGCs (voltage-controlled gain), VGAs (variable-gain amplifier), and analog multiplexers. By using real circuit transistors in the signal path, rather than just voltage or current sources as other macromodels do, Comlinear's Spice models provide superior high-frequency simulation without increased computation time. The software includes 18 high-speed, dc-coupled, op amps (-3dB-bandwidths to 350MHz; gain bandwidth product to 1.9 GHz), AGCs, VGAs, and analog multiplexers. The CLC522 wideband variable-gain amplifier, the CLC532 high-speed 2:1 analog multiplier, and the new ultra-low noise, wideband op amp (CLC425) are included. For your free Spice model, 5.25-in. IBM PC-compatible disk, contact a local Comlinear representative, distributor, or Comlinear Corp., 4800 Wheaton Dr., Fort Collins, CO 80525, (800) 776-0500 or (303) 226-0500; fax (303) 226-0564. CIRCLE 466

The 116-page Guide to NIST describes more than 250 research programs, grants, and industry outreach programs at the institute, including the Manufacturing Extension Partnership, with contact names, addresses, phone numbers, and e-mail addresses. For a free printed copy, send a self-addressed mailing label to the NIST Public Affairs Division, A903 Administration Bldg., NIST, Gaithersburg, MD 20899-0001; fax (301) 926-1630; full text is available through the Internet Gopher systems. From a remote log in, type telnet gopher.nist.gov. At the log-in prompt, type gopher. From a gopher client, use the gopher server as gopherserver.nist.gov with port 70.

EYE ON ISO 9000

Lambda Electronics Inc.'s power-supply manufacturing facilities in Tucson, Az., McAllen, Texas, Melville, N.Y., and Reynosa Mexico have been certified to ISO 9001, covering design, manufacturing, service, and support. Contact Lambda Electronics Inc., 515 Broad Hollow Rd., Melville, NY 11747; (516) 694-4200. CIRCLE 462

Analog Devices' Wilmington, Mass., facility has been certified to ISO 9001 for design, manufacturing, and customer service. The Norwood, Mass.-based company manufactures ICs for analog and digital signal-processing applications in computer peripherals, audio, video, communications, instrumentation, and military/aerospace markets. For more information, contact Analog Devices Inc., 181 Ballardvale St., Wilmington, MA 01887; (617) 937-1428; fax 821-4273. CIRCLE 463

Two International Rectifier Corp. manufacturing facilities, at El Segundo and Tijuana, Mexico, have been certified for ISO 9001 for design and manufacturing of power semiconductor devices in hermetic seal, plastic encapsulation, and module styles. IS Mexico is also registered for manufacture of ceramic power semiconductor packages. Contact International Rectifier, 233 Kansas St., El Segundo, CA 90245; (310) 322-3331; fax -3332. CIRCLE 464

QUICK NEWS: CONFERENCES & SEMINARS

The 1994 International Reliability and Maintainability Symposium and Exhibits Program will take place Jan. 24–27, 1994 in the Anaheim (Calif.) Marriott Hotel. Technical paper sessions cover many reliability and maintainability topics, including enabling technologies for concurrent engineering, application of fuzzy logic, test and evaluation, and system reliability modeling. The exposition will feature exhibits in such areas as supportability, CAD/CAM/CAE/CAT, failure analysis, and logistics. Tutorial sessions cover Markov modeling, Taguchi experiments, basic reliability, thermal design reliability, and statistical design of experiments. For more information on the conference, contact Joel Magnus, P. O. Box 765 Camden, NJ 08101.

CIRCLE 468

With tutorials, concurrent sessions, keynote addresses, and exhibits of products and services for measuring and improving quality, a conference on customer satisfaction and quality measurement will be held Feb. 27, 28, and March 1, 1994 at the Marriott Marquis in Atlanta, Ga. The conference is cosponsored by the American Society for Quality Control (ASQC) and the American Marketing Association. Contact the ASQC at 611 East Wisconsin Ave., P. O. Box 3005, Milwaukee, WI 53201-3005; (800) 248-1946 or (414) 272-8575; fax -1734.

CIRCLE 469

The Embedded Systems Conference East will take place April 19—21, 1994 at the Hynes Convention Center in Boston. Contact The Embedded Systems Conference, 600 Harrison St., San Francisco, CA 94107; (415) 905-2354; fax -2220.

CIRCLE 470

A series of free seminars will be given by Neuron Data in U. S. cities throughout January and February 1994. A morning session covers creating portable client server applications. The afternoon's session is a technical briefing on building client-server applications using Neuron Data's object-oriented, cross-platform development tools. Dates are Jan. 18, Portland, Ore.; Jan. 18, Chicago; Jan. 20, Orlando; Jan. 25, Boston; and Jan. 27, Phoenix. For February dates and more information, contact Neuron Data, 156 University Ave., Palo Alto, CA 94301; (800) 876-4900, ext. 510; fax (415) 321-9648.

CIRCLE 471

KMET'S KORNER

...Perspectives on Time-to-Market

BY RON KMETOVICZ
President, Time to Market Associates Inc.
P. O. Box 443, 100 Prickly Pear Rd., Verdi, NV 89439; (408) 446-4458; fax (408) 253-6085

To work a reasonable number of hours each day and meet time-to-market goals, a product-development team has to be smart. Team members, project managers, and executive managers have to know how to apply the equation:

Work quantity / commitment = duration

Work quantity is the work inherent in the job. Is it 100 hours, 200 hours, or 300 hours of work? This number, in the beginning, is an estimated parameter usually obtained by bottom-up summation from cross-functional team members. Commitment is the rate at which work is completed or consumed. An individual may complete work at the rate of 8 hours/day or a team of 10 team members can work at the rate of 80 hours a day. With work quantity estimated and staff assigned to do the work, duration becomes a computed parameter. A 200-hour job worked on by 3 engineers working at a rate of 24 hours/day completes the total effort in 8.3 working days.

To effectively apply the preceding equation, team members and their managers have to make good estimates. They need to be able to review a job and produce a work quantity estimate, an estimate of the number of work hours contained in the job. Once work quantity is known, management applies staff through the commitment term of the equation to set duration, or the time to market, of the project.

As a result, to have a 1000-hour job done in three months, two full-time engineers, each working slightly more than 160 hours per month, are assigned to the effort. The system is in balance for this 1000-hour job—work is known, the staffing ratio is set at near unity, and time-to-market parameters are satisfied.

It is through use of this equation that the staffing ratio of a project is set and at the same time sanity checked. Obviously, the staffing ratio and the commitment term are related. An individual working at a rate of 8 hours per day can be made equivalent to a staffing ratio of 1. Likewise, a ten-member team working 100 hours per day is related to a team staffing ratio of 1.25. It is through the computation of duration, by having some knowledge of work quantity and staffing issues, that full closure is realized.

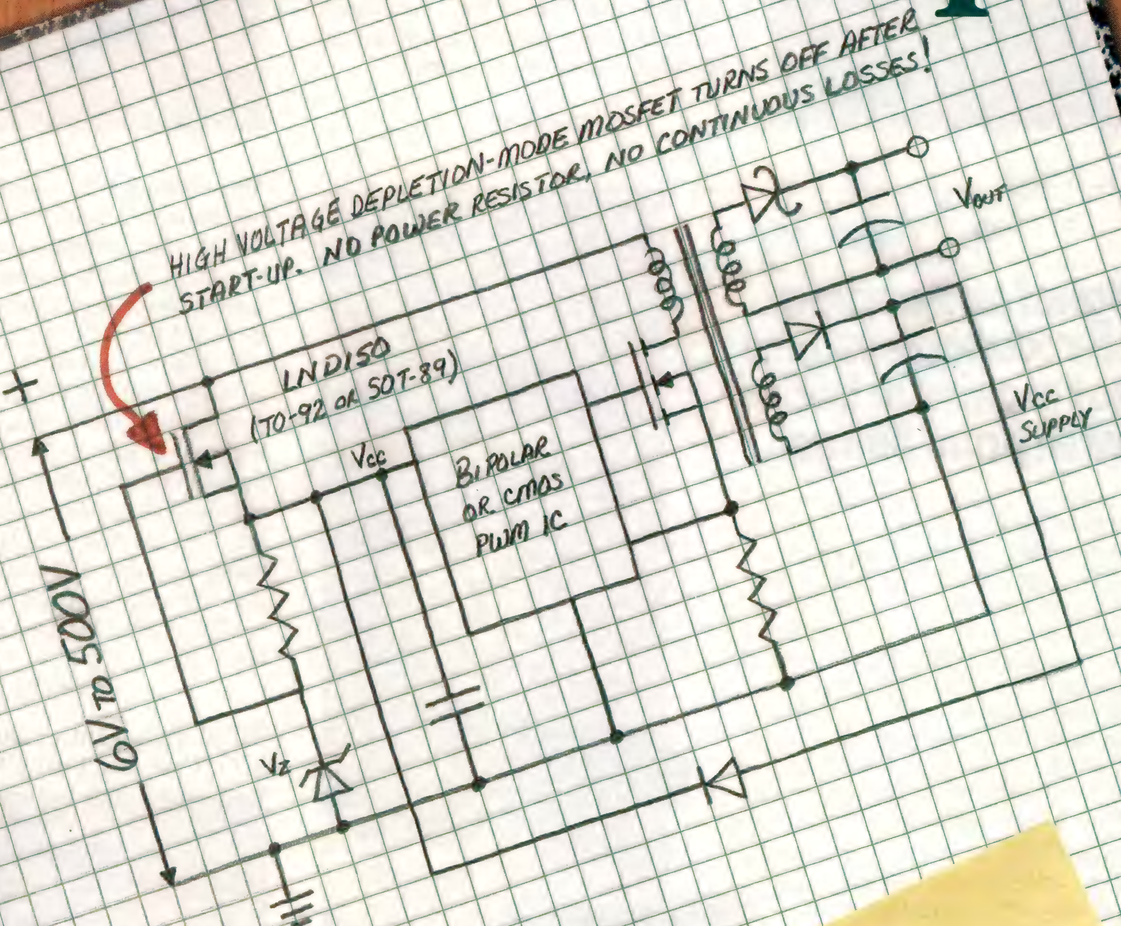
Let's now put some numbers to the equation based on the material contained in previous columns. To hit a time to market goal means that we want a normalized duration equal to 1. Under this condition, errors in work quantity estimation must be offset by corresponding increases or decreases in commitment to maintain duration equal to one. Viewed another way, if the work quantity is underestimated, and it usually is, product developers had better be prepared to work at an increased commitment to compensate for the project's growth in complexity. Bear in mind that it would be foolish to work with staff fully committed beyond a given level—there is a point at which the denominator breaks.

While simple in theory, putting the above equation to work is difficult in practice. It's hard because team members have to learn how to make good work quantity estimates. It's hard because managers have to coach team members to make better estimates. It's hard because no one can ignore good estimates. It's hard because once a realistic estimate is produced, critical project selection and staffing decisions have to be made by engineering, marketing, and manufacturing It's hard because the organization has to adjust new product output to the limits set by new product development capacity.

I'll be looking at some ways to lower barriers to effective use of duration computation in future columns. To prepare, try modeling a work day and a work week in this format.

More information on this topic is contained in New Product Development: Design and Analysis, which can be obtained by calling Time to Market Associates.

High Voltage SMPS Start-Up


HIGH VOLTAGE DEPLETION-MODE MOSFET TURNS OFF AFTER START-UP. NO POWER RESISTOR, NO CONTINUOUS LOSSES!
LND150 (TO-92 OR SOT-89)
+
6V TO 500V
Vcc
BIPOLAR OR CMOS PWM IC
Vz
VOUT
Vcc SUPPLY

John -
Great choice - Supertex
500V depletion
MOSFET #LND150!
Good riddance power
resistors! - Ron

Our solution for Switch Mode Power Supply Start-up saves power, space, cost and all the nuisance caused by power resistors. For a designer's package containing the LND150 data sheet, application notes, samples and information on High Voltage PWM ICs, call Customer Service at:

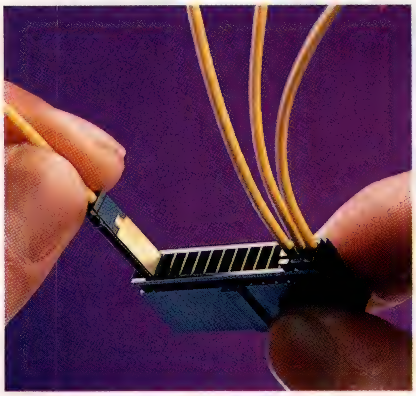
1-800-222-9884 in USA except CA
1-800-222-9883 in California

For technical data and application information contact:

Supertex inc.
Leadership in CMOS/DMOS Technologies
1350 Bordeaux Drive, Sunnyvale CA 94089
Phone: (408) 744-0100 • Fax: (408) 734-5247

CIRCLE 234 FOR U.S. RESPONSE
CIRCLE 235 FOR RESPONSE OUTSIDE THE U.S.

Controlled Impedance Ground Plane Interconnects (GPI™) are Designed to Exceed 1 GHZ System Speeds



Meritec's new Ground Plane Interconnects are engineered to match impedance and propagation rate while minimizing crosstalk. The assemblies are impedance matched from the board through the assembly to reduce signal-to-signal crosstalk. The assemblies are designed for CMOS, ECL or GaAs logic and can handle system speeds exceeding 1 GHZ with 35 picosecond rise times. A spring latch connects the termination to the housing or to Meritec's Single Signal Carrier Systems (SSC™), which allow grouped interfacing with single, dual or triple row headers. Precision, high strength molded terminations are highly reliable in critical applications.

Circle 262

Digital and analog interconnect systems that maximize board density and budget.

If you need speed and performance in a digital or analog interconnect system but have a limited budget, turn to Meritec. Meritec digital and analog interconnect systems are designed to meet the requirements of electrically sensitive applications using high speed CMOS, ECL or GaAs logic. Our systems are engineered to provide controlled impedance and propagation delay while minimizing crosstalk. You get ship to stock quality, backed up with technical service and applications support. All at a cost that's well in line with tight project budgets.

For more information and free literature on the complete line of Meritec digital and analog interconnect systems, call 216-354-3148.

MERITEC™
A DIVISION OF ASSOCIATED ENTERPRISES
Where quality assures performance

1359 West Jackson Street
P.O. Box 8003
Painesville, Ohio 44077
Phone: 216-354-3148
FAX: 216-354-0509

CIRCLE 260 FOR U.S. RESPONSE

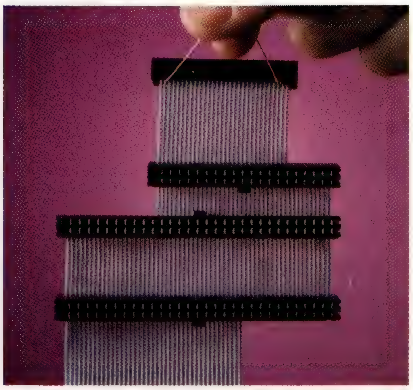
CIRCLE 261 FOR RESPONSE OUTSIDE THE U.S.

Single Signal Interconnects Offer High Performance in a Subminiature Package

Meritec's economical 1x2 and 1x3 Single Signal Interconnects (SSI™) are designed for .100" x .100" applications using subminiature coax cable. The assemblies are engineered to match application requirements for controlled impedance and propagation rate while minimizing crosstalk. The assemblies are designed for CMOS, ECL or GaAs logic. A spring latch connects the termination to the housing or to Meritec's Single Signal Carrier Systems (SSC™), which allow grouped interfacing with single, dual or triple row headers. Precision, high strength molded terminations are highly reliable in critical applications. Boxed contacts with thermo resistance welding provide the ultimate in electrical continuity.

Circle 263

Multi Signal Interconnects for TTL Fast and Fast CMOS Logic



Meritec's controlled impedance Multi Signal Interconnects (MSI™) are designed for TTL fast and fast CMOS logic. The high performance assemblies are available in standard end-to-end terminations or can be daisy chained for special applications. Abrasion-resistant jacketing and EMI/RFI electrical shielding are optional. The connectors mate with standard .025" square or round pins on a .100" grid. Precision, high strength molded terminations provide high reliability in critical applications.

Circle 264

CIRCLE 521

CORRECT V_{OS} WITH NO EXTRA PARTS

KERRY LACANETTE
National Semiconductor Corp., P.O. Box 58090, Santa Clara, CA 95052-8090.

If you use a DAS chip (or multichannel ADC) with "mux out" and "ADC in" pins, the offset voltage of your data-acquisition system's amplifiers, filters, and other analog-signal-processing components can be corrected without extra components or digital control lines.

A standard technique for correcting the V_{OS} of an amplifier in a data-acquisition system is to connect the amplifier's input to ground (or another appropriate system reference point) and use the system's ADC to measure its output voltage with respect to the input. The microprocessor can then subtract this error voltage from subsequent measurements. But, even though this technique is simple in concept, analog switches usually must be added to the system to disconnect the amplifier from the signal source and connect its input to a reference potential. These switches must be controlled by the system's processor, and additional digital control lines must be dedicated to them.

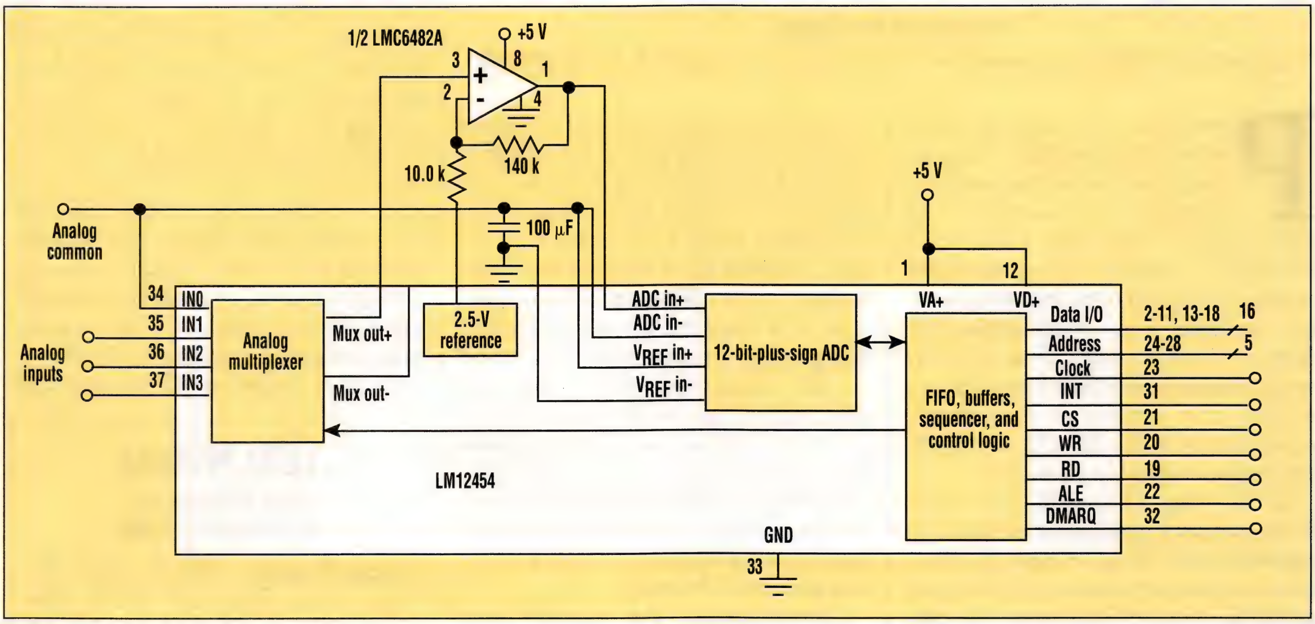
Using a data-acquisition system chip's internal multiplexer to connect the amplifier's input to either a signal source or a reference point for offset correction eliminates the external switches and control lines *(see the figure)*. The DAS chip has four analog inputs, any combination of which can be connected to the two "mux out" pins. One of the two "mux out" pins drives the op amp's input. Because the circuit operates from a single +5-V supply, the amplifier's feedback network is referred to 2.5 V. The amplifier operates at a gain of 15, which can result in an output offset voltage as large as ±20 mV (±33 LSB) from –40°C to +85°C.

The amplifier's output drives one of the two differential ADC inputs on the DAS chip. To calibrate the op amp's offset voltage, channel 0 should first be selected, followed by performing a conversion. The conversion result will indicate the amplifier's output offset. Because the ADC's negative input pin is connected to the 2.5-V reference, the conversion result will indicate either positive or negative offset referred to 2.5 V. This correction factor is then stored in system memory.

The three remaining multiplexer inputs are available to connect analog signal sources to the ADC through the amplifier. After performing a conversion, the stored correction factor can be subtracted from the conversion result to provide an offset-corrected result. Note that all multiplexer switching is controlled through the DAS chip's digital interface; no additional control lines are needed. The system can be recalibrated if, for example, the ambient temperature changes significantly and it's suspected that the amplifier's offset has drifted.

This circuit can be easily modified to operate from a +3-V supply by replacing the LM12454 with an LM12L454. The LM12L454 has no internal reference, so it's best to use an external voltage reference that will work from a +3-V supply. A simple fixed shunt reference (LM4040-2.5, LM385-2.5, etc.) will work effectively.

Although an amplifier is the sole analog-signal-processing component in the circuit, this method enables you to correct the offset of other analog-signal-processing components (filters, peak detectors, etc.). The technique works with other DAS ICs and ADCs that have "ADC in" and "mux out" pins which can be programmed with sufficient flexibility.☐



BY TAKING ADVANTAGE of "mux out" and "ADC in" pins on an ADC or DAS chip, the offset of a data-acquisition system's op amps can be measured and corrected.

CIRCLE

522 ANALOG SWITCH USES SINGLE SUPPLY

BRIAN R. BEER
VG Analytical, Fisons Instruments, Floats Rd., Wythenshawe,
Manchester, United Kingdom M23 9LE.

VOTE!

Read the Ideas for Design in this issue, select your favorite, and circle the appropriate number on the Reader Service Card. The winner receives a $150 Best-of-Issue award.

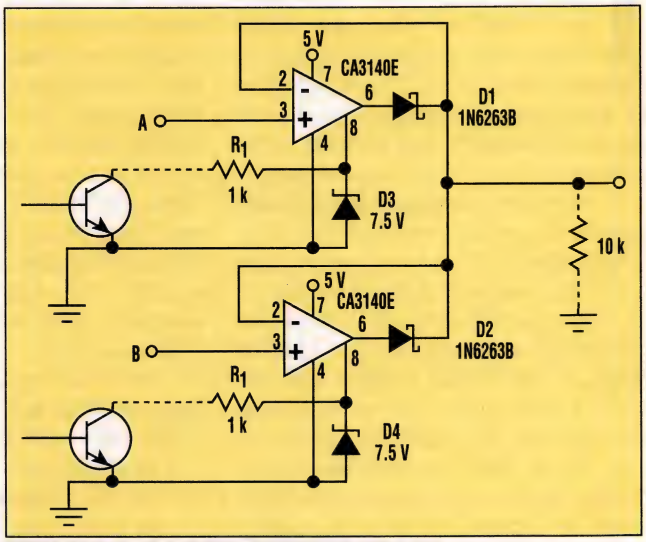
This design takes advantage of the strobed output stage of a CA3140 amplifier *(see the figure)*. With the strobing capability, the circuit's output voltage can be set to either of the input voltages by grounding one of the control inputs, either A or B.

When the strobe input at pin 8 is taken below 1 V, that amplifier is disabled. The remaining amplifier then acts as a unity-gain high-impedance buffer.

The 10-k output resistor enables the output voltage to swing down to 20 mV from ground. Although the Zener-diode clamps and associated resistors connected at the strobe inputs may be omitted for the lowest-cost applications. However, experience has shown that they allow the amplifiers to shrug off the effect of high transient voltages.

The circuit is particularly suited to 8-bit microcontroller applications, where the strobe inputs may be driven directly from two open-collector output ports under software control.

The use of Schottky diodes for D1 and D2 makes possible an output swing of 2.5 V when the circuit is powered from a 5-V supply.☐



THE STROBED OUTPUT STAGE of a CA3140 amplifier enables its output voltage to be set to either of the input voltages by grounding one of the control inputs.

CIRCLE

523 GET ABSOLUTE TEMP LOG WITH RS-232

W. STEPHEN WOODWARD
Venable Hall, CB3290, University of North Carolina, Chapel Hill, NC 27599-3290.

Products that can acquire physical quantities, such as temperature, with personal computers abound in the marketplace. However, these may represent "overkill" when the task at hand is limited to monitoring a single variable. The circuit shown offers a simpler way to accurately sense and log absolute temperature using any generic PC that's equipped with an RS-232 communications port *(see the figure)*.

In the setup, T1 (an LM334 temperature sensor) generates a constant current that's proportional to absolute temperature, and equal to 25 μA at 323 Kelvin (50°C). R_1 sets this constant of proportionality. The current discharges the parallel combination of C_1 and C_2 connected to the trigger and the threshold pins of U1, which is a CMOS implementation of the venerable 555 analog timer. The negative-going ramp is compared by U1 to an internal 2.5-V trigger level controlled by Z1. When the ramp gets there, U1 triggers. The output pin (3) will go high, presenting a "start" bit to the connected communications port, which causes Q1 to source 100 μA to the timing node. At the same time, the discharge pin (7) will open, allowing R_2 and the bottom end of C_1 and T1 to float. This prompts the current sunk by T1 to be supplied by C_1, and isolates it from C_2.

Consequently, the current supplied by transistor Q1 will go solely to C_2, so that when the resulting positive-going ramp reaches 5 V, exactly 25 nC (2.5 V × C_2) will have been deposited in the timing node by the recharge cycle. U1 will then terminate the recharge cycle because its threshold level (6) will have been reached. This causes both the output pin to return to the negative rail, restoring the "marking" condition of the RS-232 interface, and Q1 to stop recharging C_2. U1's discharge pin (7) now reconnects R_2 to the negative rail, causing the charge that was deposited by T1 on C_1 during the recharge interval to rapidly redistribute between C_1 and C_2. This arrangement creates a very linear (0.01%) relationship between T1 current and

IFD WINNER

IFD Winner for September 2, 1993

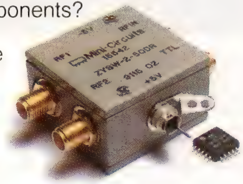
Dana Romero, 5036 S. 2000 W., Salt Lake City, UT 84118. His idea: *"Sense Fluid Levels With Capacitance."*

SPDT switches with built-in driver

ABSORPTIVE or REFLECTIVE dc to 5GHz

Truly incredible…superfast 3nsec GaAs SPDT reflective or absorptive switches with built-in driver, available in pc plug-in or SMA connector models, from only $14.95. So why bother designing and building a driver interface to further complicate your subsystem and take added space when you can specify Mini-Circuits' latest innovative integrated components?

Check the outstanding performance of these units…high isolation, excellent return loss (even in the "off" state for absorptive models) and 3-sigma guaranteed unit-to-unit repeatability for insertion loss. These rugged devices operate over a -55° to +100°C span. Plug-in models are housed in a tiny plastic case and are available in tape-and-reel format (1500 units max, 24mm). All models are available for immediate delivery with a one-year guarantee.



SPECIFICATIONS (typ)	Absorptive SPDT YSWA-2-50DR ZYSWA-2-50DR			Reflective SPDT YSW-2-50DR ZYSW-2-50DR		
Frequency (MHz)	dc-500	500-2000	2000-5000	dc-500	500-2000	2000-5000
Ins. Loss (dB)	1.1	1.4	1.9	0.9	1.3	1.4
Isolation (dB)	42	31	20	50	40	28
1dB Comp. (dBm)	18	20	22.5	20	20	24
RF Input (max dBm)	——	20	——	22	22	26
VSWR "on"	1.25	1.35	1.5	1.4	1.4	1.4
Video Bkthru (mV,p/p)	30	30	30	30	30	30
Sw. Spd. (nsec)	3	3	3	3	3	3
Price, $ (1-9 qty)	YSWA-2-50DR (pin) 23.95 ZYSWA-2-50DR (SMA) 69.95			YSW-2-50DR (pin) $14.95 ZYSW-2-50DR (SMA) 59.95		

finding new ways…
setting higher standards

Mini-Circuits™

WE ACCEPT AMERICAN EXPRESS AND VISA

P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661

Distribution Centers / NORTH AMERICA 800-654-7949 • 417-335-5935 Fax 417-335-5945 EUROPE 44-252-835094 Fax 44-252-837010

For detailed specs on all Mini-Circuits products refer to • THOMAS REGISTER Vol. 23 • MICROWAVES PRODUCT DIRECTORY • EEM • MINI-CIRCUITS' 740-pg HANDBOOK

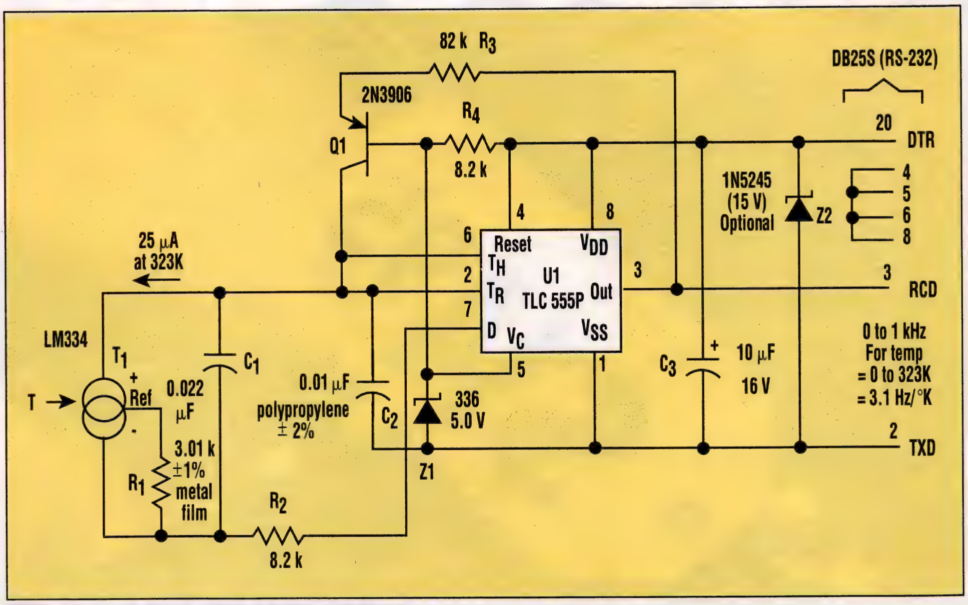
CIRCLE 134 FOR U.S. RESPONSE **CIRCLE 135 FOR RESPONSE OUTSIDE THE U.S.**

F141 REV. D

pulse output frequency.

While this is happening, the PC's communications port hardware assembles a valid (although meaningless) character, because the positive pulse output by U1 looks like the start bit of a character. A simple program running in the PC can then count the frequency of these characters and convert the resulting rate into a direct readout of temperature. Due to the 3.1-Hz/degree slope of frequency versus temperature, a 30-second average suffices for 0.01° resolution.

Because of the intrinsic properties of the LM334, a single point calibration is satisfactory to ensure accurate temperature conversion, and the resulting constant can easily reside in the data-handling software. Thus, no trimming procedures or components are necessary in the circuit. All power requirements of the converter are satisfied by the communications port itself, and thus no batteries or other power sources are required.☐



ABSOLUTE TEMPERATURE can be sensed and logged simply using this circuit setup. All that's required is any common personal computer equipped with an RS-232 communications port.

These Days, It Takes More Than A Wish To Make Your Dreams Come True.

Most of the time, it takes money. And that means starting to plan now so that you can reach your goals in the future. That's why you should invest in U.S. Savings Bonds. With just a little money from each paycheck, you can buy Bonds through the Payroll Savings Plan at work. Find out how U.S. Savings Bonds are making American dreams a reality. Ask your employer or call 1 800 4 US BOND for more information.

U.S. Savings Bonds
Making American Dreams A Reality
A public service of this magazine

EDITORIAL CALL WANTED: SOFTWARE IDEAS FOR DESIGN

Electronic Design will publish five special supplements during 1994 focused on engineering software. For those supplements, we are looking for the software equivalents to Ideas for Design: brief, tightly focused articles that describe short software routines, problem-solving tips on writing embedded code, etc.

We will pay $100 for each Engineering Software IFD we publish. Articles should be a maximum of approximately one typewritten page of text with one or two code listings or block diagrams. They should represent the author's original work, and should not have been previously published.

Send your Engineering Software Ideas for Design to:

Stephen E. Scrupski
Editor-in-Chief
Electronic Design
611 Route 46 West
Hasbrouck Heights, N.J. 07604
Telephone: 201-393-6070
Fax: 201-393-0204

VI-HAM™

Harmonic Attenuator Module

- Up to 600 Watts of Output Power
- Booster Versions Available
- Meets IEC 555
- High Efficiency
- Module Enable and Power OK
- Size: 4.6"L x 2.4"W x 0.5"H

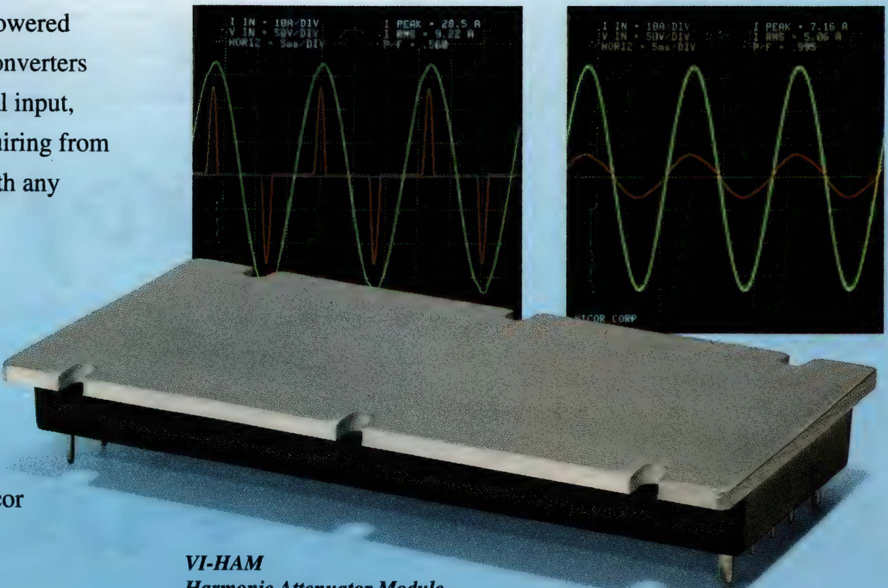
The pressure is on to wring more and more usable power from a standard AC outlet—safely and economically—and to pack the necessary power processing capability into ever smaller spaces.

Solution: the VI-HAM Harmonic Attenuator Module. This component-level front end—in the industry standard package—provides unity power factor for line powered systems anywhere in the world. Vicor DC-DC converters and VI-HAM modules together create a universal input, off-line switching power supply for systems requiring from hundreds of watts to kilowatts of total power, with any number of outputs, from 1 to 95 VDC.

Use VI-HAM modules with Vicor VI-26X (full size) or VI-J6X MiniMod™ DC-DC converters in booster expandable arrays to satisfy a wide range of power demands. And when your system has to meet international standards for EMI/RFI emissions, choose the Vicor filter that fits your need.

Build new flexibility into *your* power system designs with the VI-HAM module. Call today for details.

Left: no power factor correction
Right: power factor correction with the VI-HAM



VI-HAM
Harmonic Attenuator Module

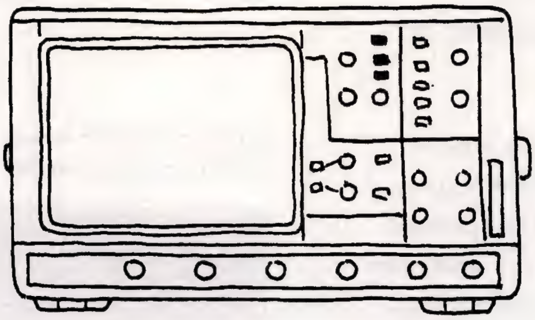
Component Solutions For Your Power System

Vicor Corporation, 23 Frontage Road, Andover, MA 01810 (508) 470-2900 or (800) 735-6200
Vicor GmbH • Germany • Tel: +49-89-329-2763 • Fax: +49-89-329-2767 **Vicor Far East** • Taiwan • Tel: +886-2-9188240 • Fax: +886-2-9132982

VICOR

CIRCLE 161 FOR U.S. RESPONSE CIRCLE 162 FOR RESPONSE OUTSIDE THE U.S.

FASTER
DEEPER
SMARTER
BETTER.



LeCroy

The most powerful Digital Scope
in the industry arrives February 1ST.
(Curious?)

800-4-LeCroy

LeCroy
Innovators in Instrumentation

CIRCLE 242 FOR U.S. RESPONSE CIRCLE 243 FOR RESPONSE OUTSIDE THE U.S.

PEASE PORRIDGE

WHAT'S ALL THIS TIME MANAGEMENT STUFF, ANYHOW?

Once upon a time, in 1956, I was attending Mount Hermon School in central Massachusetts. At the end of the school year, I was asked to stay over to help out at Commencement ceremonies. I didn't think anything of it at the time. I wandered into the Commencement ceremonies, and was quite surprised when they announced that the winner of the second prize for writing Book Reports, for the Junior Class, was Robert A. Pease.

I nonchalantly ambled up to accept the prize—and tried to recollect—when did *I* write any Book Reports? After a good deal of thought, I remembered the gray January afternoon when, after lunch, I went down to the Library with a high-priority assignment: Because of my procrastination, I had to read 3 books and write book reports on all 3 by 5:00 PM—*on that day*. Well, I sort of read 3 books *real fast* and wrote a report about each book, and I handed in the reports by 5:00 PM. As a matter of fact, I did recollect that my English teacher, Mr. Jack Baldwin, had not returned those book reports to me....

BOB PEASE OBTAINED A BSEE FROM MIT IN 1961 AND IS STAFF SCIENTIST AT NATIONAL SEMICONDUCTOR CORP., SANTA CLARA, CALIF.

And then in June the English Department judged that I had shown some *excellence* in the art of writing about some books I had read. To this day, I don't have any record of what I wrote. I don't think I ever did get those 3 book reports back from my teacher, nor do I even recall exactly what 3 books I wrote about. But I must have done a pretty good job of planning what I wanted to say on the first draft, because that was the only draft that ever got done....

The other day I went to take some training in a course on "Time Management." I showed up *promptly* at 8:30 AM and settled down to hear Tom, the instructor ask, "What if you haven't fulfilled the tasks you had to do? What do you feel?" Then we all knew how to speak out, "GUILT." And the instructor went on, "... and guilt, added to procrastination, tends to causes paralysis, and forces your productivity even lower....leading to more paralysis...." LOWER?

At exactly that point, I began to recall the circumstances of my book reports. Did my procrastination in writing book reports cause me to be guilty and lose all productivity? I knew I had a job to do, so I did it. And I was rewarded for "a job well done." Guilt and paralysis did *not* take over.

I was especially reminded of this because at the exact same time that I was listening to Tom explain about guilt, procrastination, and paralysis, I was not paralyzed—I was writing down the specs for a new data converter. I had designed the circuit a couple days ago, and a report was due. I had not had enough time to write down the specs, even though I knew in my head what I meant to do. So I documented my notions on paper during the "Time Management" lecture....

In the fall of 1959, a couple years after I won that Book Review award, I was going to MIT, living out in the slums of Cambridge. I decided to try to live within my budget. I got a notebook, and I logged in the money I had at the beginning of the term—perhaps $125.50, as I recall, and then I wrote down all my purchases and expenses. As I approached the end of the term, my budget notebook said that I had $2.85 left, after subtracting all my expenses from my balances. I looked in my wallet. I had $12.85 left. I double-checked my subtraction. No errors. So I decided that I had two choices: either throw away that discrepant $10 bill, or, throw away the notebook. After 2 seconds, I decided to throw away the notebook, *not* the $10 bill. I never went back to trying to have a "budget" again, if it would lead me to a choice as silly as that.

Try and think of a budget you can beat—mere dollars. Now think of a budget you can hardly beat—minutes and hours. (Let's ignore strange time-zone games.) If all 24 hours in a day were available for all tasks, would you still need to borrow some more hours? If time is money, is there anything more valuable, more irreplaceable, than *time*?

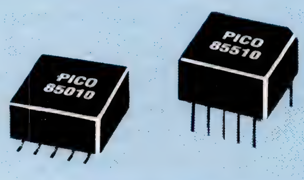
I value my time. I don't get up at 5:30 AM, work all day, and then study things until after midnight as a joke. So why do we play games with time? As I said, I value my time. Often on a weekday evening, I may "borrow" an hour from the weekend. When I get to Saturday, I am *shot*, and I know I have built up a sleep deficit. I know I have to pay back some of my sleep debt. I need to take a nap. Okay.

After a nap on Saturday afternoon, and perhaps on Sunday, too, I have gotten honest enough to balance my *sleep* budget. I pay my debts. I can live through next week....

Once the Time Management lecturer, Tom, finished explaining about paralysis, he suggested that we should list, describe, define, and prioritize our goals and objectives. If we *say* that our families are first, but we *admit* that on 5 days a week our higher priorities are for taking care of our job, is that bad? No, being honest about our priorities is probably *good*. Is it bad for RAP to have a priority when it comes to replying to any

PICO

Multiplex
Data BUS
Pulse
Transformers
MIL-STD-1553



Actual Size
.4″ × .4″ × .2″Ht.

- Surface Mount
- Plug-In
- QPL Standards MIL-T-21038/27C
- MIL-STD-1553

These pulse transformers manufactured to MIL-STD-1553 COMMAND/RESPONSE MULTI-PLEX DATA BUS requirements. They also are manufactured to MIL-T-21038/27C specifications and are designed to meet MAC AIR SPECIFICATIONS A3818, A5690, A5232 and A4905.

All of these transformers exhibit superior electrical performance. Common mode rejection ratio is greater than 45dB at 1 MHz. Input impedance is greater than 3000 ohms over the band from 75 kHz to 1MHz at 1V rms. This series possesses exceptional waveform integrity: Rise time and fall time is less than 100 nanoseconds. Overshoot and ringing is less than ± 1V peak. Droop is less than 20%.

Delivery—
stock to one week

See EEM
or send direct
for Free PICO Catalog.
Call toll free 800-431-1064
in NY call 914-699-5514
FAX 914-699-5565

PICO Electronics, Inc.
453 N. MacQuesten Pkwy., Mt. Vernon, N.Y. 10552

CIRCLE 190 FOR U.S. RESPONSE
CIRCLE 191 FOR RESPONSE OUTSIDE THE U.S.

reader who writes a letter or asks a question? The answer may not be so simple.

But the Time Management instructor went on to list all of the things we typically want to do in a day. Even without wasting any time, if we allocate time only to tasks that are of high value, there's not any time left at the end of the day, he observed. "If I'm doing one thing, then I'm not doing another—so I am procrastinating...."

Then we went to lunch. I had a choice: I could either make a couple phone calls, or get some info off a computer, or eat lunch. What was my highest priority? Easy—I did all three. I munched a sandwich and waited for the computer to boot up. Called Bob Milne and left a note on his phone machine. Ate a cookie and talked to a couple other guys while ordering the printer to print out. Obviously, one-track-minded people who can only do one thing at a time would have a disadvantage. I know a guy who used to read a book as he drove to work.

Still, no matter how carefully you manage your time and tasks, I'm sure that you, too, tend to run out of time before you run out of tasks. Everybody who is any good at anything always gets loaded up with more tasks than he/she can conveniently accomplish—and is always too busy....

What if I could buy a little machine, no bigger than a VCR, that I could set beside my bed? After I turn it on, I go to bed, good and tired, at 3 AM. Then I would awaken at 5 AM feeling as refreshed as if I had 8 hours of sleep. Maybe 1 day per week I would need to put in a little debt-make-up sleep, but that's not a big deal. WHAT amount of $$$$ would you be willing to charge on your VISA card to pay for that box—the box that gives you back 6 hours per day??? Would it help you get your job done, and your tasks around the house, too? Unfortunately, at this time I do not know where you can buy that "time machine." But I have been told that when it becomes available, it will have a Russian patent number on it.

The lecturer from Franklin Time Management did not try to brow-beat us into using his "Daily Planner System." He just pointed out that anybody who already had enough money for financial security for his family for the rest of his life did not have to worry about saving time. But the rest of us might consider that if there's a system which makes us more efficient so that we can get all our work done promptly, and then have time left over for FUN and personal PROFIT, then we really might want to exploit that system. A good pitch—a wise salesman, proposing to sell us the one thing we can't buy anywhere—a "time machine."

Should I worry about my usage of my time? Should I feel *guilty*? Well, it's not the kind of thing that worrying, or panicking a lot, will make better. If I am doing my job, then inventing new worries out of thin air will not help anybody.... However, being dishonest about my time is not so good, compared to just being honest. If I'm able to keep my boss happy, but my kids never see me, and my wife gets frustrated because I'm never around when she needs me, maybe my allocation of time isn't so good. Maybe I could use some kind of "time machine" to help me find the time to do the things I really want to do.

After all, some of the things I use my time for aren't as valuable as others —though I may not find out exactly which ones they are for many years. What if I spend a few hours to help some guy with a thorny problem? Can I justify that if the guy only works for a little company, not a huge corporation? Well, sometimes it does make the customer feel really good about me and my products and my company. Sometimes this makes good business for his company and mine, too. And other times I guess I probably wasted my time. But, even the Time Management Experts were honest enough to reprint a quote by Francois Auguste Rodin: "Nothing is a waste of time if you use the experience wisely."

All for now. / Comments invited!
RAP / Robert A. Pease / Engineer

Address:
Mail Stop D2597A
National Semiconductor
P.O. Box 58090
Santa Clara, CA 95052-8090

Striking Performance

IDT's 8ns Cache Tag

It's the Match that Counts

Until now, 60MHz+ systems could not retrieve the first burst of secondary cache data in less than 3 clock cycles. With a cache tag Address-to-Match time of 8ns, this limitation goes up in smoke. The IDT71B74 enables the secondary cache to retrieve the first data burst in a striking 2 clock cycles.

Fastest Match Possible

A very fast cache tag is a prerequisite for attaining true zero-wait-state secondary cache operation in very high-speed systems. At 8ns, the IDT71B74 provides a match/no match response in the fastest time available for an estimated 16% improvement in overall secondary cache performance.

Performance Leadership

The 8ns IDT71B74 cache tag is available in a space-saving 28-pin SOJ package to minimize board space and improve electrical performance.

IDT is the leader in high-speed SRAMs, offering a wide array of speeds and configurations in both component and module packaging options.

Make a Match

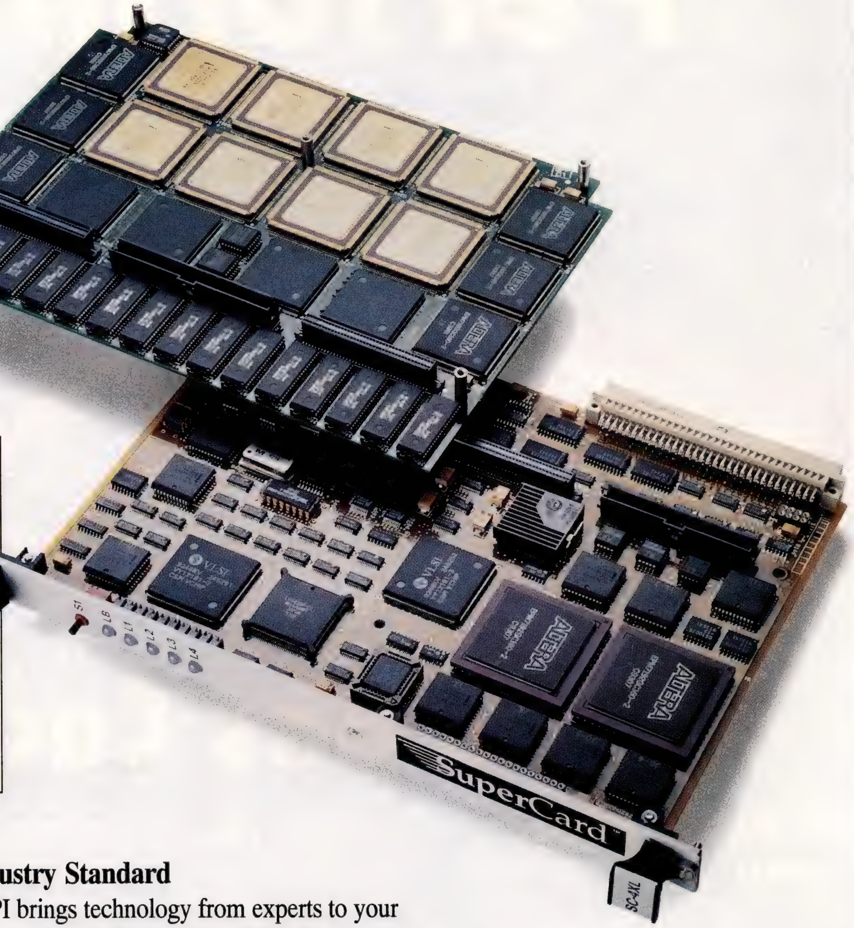
Call or FAX us today to receive a series of **application briefs**, a **data sheet**, and a **sample request card** so you can match our 8ns cache tag with your high-speed processor.

(800) 345-7015 ▲ FAX: 408-492-8674

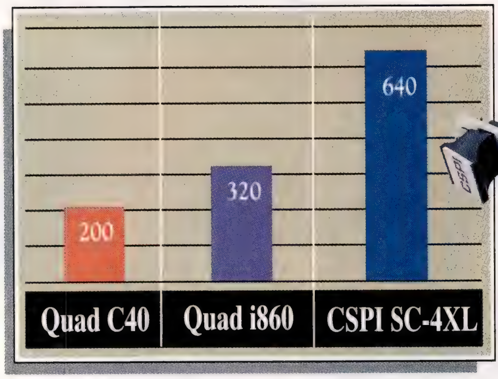
ASK FOR KIT CODE 8091

Integrated
Device Technology, Inc.

The Logical Choice for Multiprocessor Power – SuperCard-4XL Architecture



Million floating point operations per second on 6U VME board



Fastest Hardware

The need for processing power is insatiable for real-time multiprocessing solutions in defense, industrial, and medical applications. Greater resolution, faster I/O, larger data sets, and higher throughput all require signal and image processing technology pushed to the limit.

The SuperCard-4XL fulfills these needs – it's fast, compact, and very reliable! In fact, CSPI is the only vendor today offering up to 640 MFLOPS in a single 6U VME slot.

Our method is simple – group eight processors in pairs to create four processing elements on board. Hand coded library functions offer transparent access to this pipelined parallelism.

Best Value

With a list price of $47/MFLOP, we make no compromises to provide the maximum density of floating point power at the lowest price. And, with over 3,000 SuperCards operating in the field, reliability is assured.

Industry Standard

CSPI brings technology from experts to your program team. Our partners range from industry recognized leaders to distinguished younger companies. Select CSPI's open software solutions for real time multitasking/multiprocessing C and Ada development, plus graphical programming capabilities and a new parallelizing interface.

CSPI's commitment to hardware standards is designed into the SuperCard Family.

- VSB connectivity is maintained on board for compatibility with third party products
- VME64 is included for maximum bandwidth on the system bus
- National Semiconductor's QuickRing technology is selected for scalable high-speed board-to-board interconnect

MIL-spec

Our MIL-spec partner, Hughes Aircraft Company has developed a SuperCard XL model for MIL-spec environments.

Capture the Power

Call Susan Snell Solomon at **1-800-325-3110** and we'll demonstrate how SuperCard power can be harnessed by your application. A copy of our white paper *Scalable Interboard I/O for Multiprocessing DSP Applications* is yours for the asking.

Scaleable Interboard I/O for Multiprocessing DSP Applications

CSPI

Innovations in Embedded High-Performance Computing

40 Linnell Circle, Billerica MA 01821
508-663-7598 Fax: 508-663-0150
In Europe, CSPI, Paris, France 33-1-43774577
Fax 33-1-43994508

CIRCLE 102 FOR U.S. RESPONSE CIRCLE 103 FOR RESPONSE OUTSIDE THE U.S.

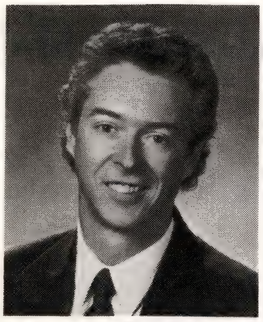
PC GRAPHICS WATCH

75-HZ MONITOR TIMING

DEAN HAYS, CHIPS & TECHNOLOGIES

Due to increasing interest in workplace ergonomics, computer-display flicker is emerging as an important issue. Earlier 60-Hz refresh rates are no longer acceptable, and many individuals can still perceive flicker when using some of the newer timings, such as 70 or 72 Hz. For this reason, the VESA Monitor Committee developed standard computer-display timings with refresh rates above 72 Hz.

Early in this effort, the choice of rates narrowed to two—75 and 76 Hz. The 75-Hz rate eventually was recommended based on several criteria. First, 75 Hz offers nearly indistinguishable flicker performance compared to 76 Hz and meets current ergonomic requirements for all common screen sizes. For larger screen sizes, complete ergonomic compatibility may still require a refresh rate higher than 76 Hz. More importantly, in multimedia applications, 75 Hz offers a better match to the European 50-Hz (25 frames/s) video standards, and is reasonably compatible with the NTSC standard of 60 Hz (because 75 and 60 share 15 as a common factor). A 75-Hz refresh rate is also acceptable to the film industry, which typically operates at 24 frames/s (for which 72 Hz is an integer multiple), but has shown acceptable results with the 4% hike to 25 frames/s for the European market (for which 75 Hz is an integer multiple).



The 75-Hz timing standards were therefore created for the four most common screen formats in use today: 640 by 480, 800 by 600, 1024 by 768, and 1280 by 1024 pixels. The VESA voting community approved the standards in early October. Specifications are provided in VESA's VDIF (VESA Display Information Format). VDIF is intended as a means of supplying timing and other information in the form of a file that's readable by the host system. This would provide the exact timing, in terms of pixels, characters, and lines. For better readability, the standard also adds the timing information in terms of the more familiar active time lines, blanking times, front and back porches (the duration of the blanking period before the leading edge of the synchronization pulse), and so on.

Several measures ensure that the standard supplies refresh rates as close to 75.000 Hz as possible while maintaining compatibility with existing controllers and displays. First, all timings are specified in 8-pixel characters, which is the smallest increment that timings can be programmed or changed in many controllers. Next, an attempt was made to employ a reasonable set of standard pixel frequencies (dot clocks) that could easily be synthesized by many video controllers.

To further maximize the standard's video capability, the frequencies were arranged in multiples of 2.25 MHz, which is the lowest common multiple of the NTSC and PAL/SECAM line rates. Preference was given to multiples of 13.5 MHz, which is the standard sampling rate specified by CCIR-601. The 640-by-480- and 800-by-600-pixel timings provide exactly 75.000-Hz refresh within these constraints, using pixel frequencies of 31.5 MHz and 49.5 MHz, respectively. The two higher-resolution formats couldn't achieve exactly 75 Hz—the 1024-by-768 and 1280-by-1024 timings supply 75.029 and 75.025 Hz, respectively. However, the standard offers alternative approaches in order to hit exactly 75.000 Hz. All frequencies can be generated by controllers using a reference clock that provides multiples of 2.25 or 13.5 MHz within reasonable tolerances.

These frequencies were selected so that existing controller technologies could attain them. The blanking times and synchronization pulse positions were chosen for compatibility with existing monitors. For example, 80 MHz is a typical upper-frequency limit for many controllers and 8-bit color palette chips. Therefore, the 1024-by-768 timing employs a 78.750-MHz pixel frequency. Many higher-end controllers, intended for use at 1280 by 1024 pixels at rates above 70 Hz, can operate at 135 MHz. Hence, 135 MHz was chosen for the 1280 by 1024 timing.

The blanking times and synchronization pulse widths and positions, chosen to work with existing displays, were tested by a number of monitor manufacturers. The front-porch times were set to the minimum acceptable level in all cases so that they could be handled by most existing monitors. This level equals 2 characters times 16 pixels for the horizontal timing and a single line for the vertical. The standard synchronization polarities also were selected to conform with past standards: 640 by 480 uses negative polarity, while the other three resolutions all employ positive polarity.

For more information about VESA's monitor timing standards, contact the VESA office at (408) 435-0333.

Bob Myers, of Hewlett-Packard, contributed to this column.

Why just give a present, when someone special to you celebrates a birthday, wedding, the birth of a child, the holidays or any other special day? Instead, give a gift that's as special as the day itself — a U.S. Savings Bond. After all, **when you can give** someone a piece of the future, you show you care today — and tomorrow. Get U.S. Savings Bonds at your bank, and be sure to ask for a U.S. Savings Bond gift certificate. Then, when someone special to you celebrates a special day, give U.S. Savings Bonds. You'll give **a piece of the future.**

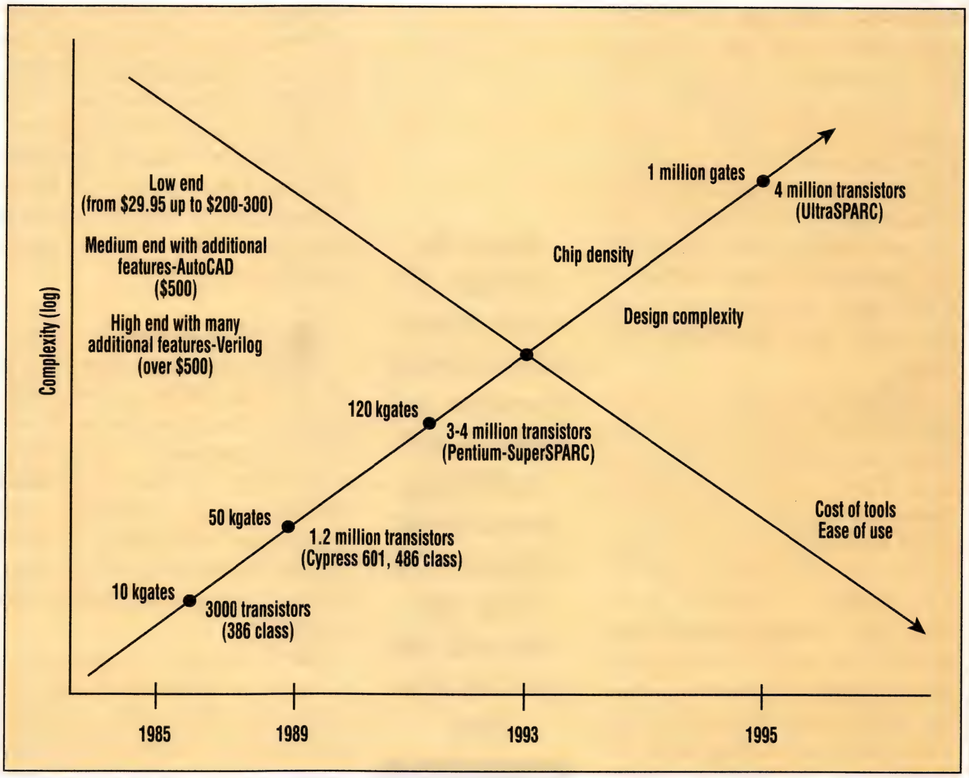
Take Stock in America
U.S. SAVINGS BONDS
A public service of this magazine

Embedded Designs Follow CPU Curve

As processors become more powerful, designs are growing more robust.

BY BARRY BARRETT

Sun Microsystems, 2550 Garcia Ave., Palo Alto, CA 94043; (415) 960-1300.



Though the complexity of microprocessors is on rise, development tools are becoming easier to use and their cost continues to plummet. This will translate into higher performance embedded designs.

The advent of faster, denser architectures has radically changed how embedded applications are developed, while greatly accelerating their time to market. Case in point: While making a relatively small investment, designers can build a robust development environment, complete with a standalone workstation and a new generation of tools that are based on graphical user interfaces or designed with an object-oriented technology.

This revolution, so to speak, is taking place on a couple of fronts. The increased density of microprocessors has led to a higher level of integration in embedded systems and a commensurate reduction in manufacturing costs. Due to the increased CPU speed, developers don't have to employ assembly code to create real-time applications. On the contrary, they can stay with higher-level compiled languages that not only reduce development time, but facilitate portability. Moreover, the design tools themselves have grown far more sophisticated. Designers needn't work at the logic gate level—the latest development tools can generate a board layout based on a set of functional criteria.

As recently as five years ago, embedded designs based on an Intel 8086 or a Zilog Z8000 would require peripheral ICs for I/O and memory. In addition, any custom-designed circuitry had to fit within the confines of a semicustom chip with a limit of about 10,000 gates. Such implementations were costly, sometimes escalating to $40,000. The only single-chip solutions were found at the low end of the performance spectrum, such as in consumer products.

In the past, the comparatively thick line widths of semiconductor processors invariably led to large chip sets on many embedded systems. This was particularly true in high-end designs because of the limited number of transistors that fit on one chip and the number of usable die that existed on the smaller wafers then in use.

One of the principal effects of the microprocessor revolution has been to shift the dividing line between high-end multichip solutions and single-chip solutions. Ten years ago, semiconductor line widths exceeded five microns; today they're about a tenth that size, with a hundred times the density. By the same token, wafers have increased from 2 or 3 in. in diameter, up to 8 in. As a result, more applications can be integrated into a chip and less chips are needed for multiple chip solutions. Because wafer costs through the years have been fixed at about $1500, regardless of their size, larger wafers have reduced the cost per chip.

A good example of the trend toward higher IC integration is the GX graphics chip from Sun Microsystems, Mountain View, Calif. The part replaces a board-size multichip solution with one chip containing thousands of transistors. All that's needed to form a complete graphics-accelerator design is the GX chip, up to 1 Mbyte of video RAM, and a clock crystral. It will support resolutions up to 1600 by 1280 pixels.

Fax modems represent another example of how integration is affecting embedded designs. Modems had become a single-chip device until the popularity of fax capability brought back multiple-chip implementations. Now, however, a 32-bit RISC processor, combined with some dedicated logic, can shrink the chip count to just two in a high-end fax-modem. Similarly, X-terminal architectures that once required a full board of logic chips can now be implemented using just two or three chips plus some memory. For example, the chip set found on Sun's X-terminals consists of a microSPARC CPU and master and slave (MACIO and SLAVIO) I/O chips.

Perhaps the most dramatic example of component integration is the personal digital assistant (PDA), such as the Apple Newton Computer and the Personal Communicator developed by Eo Inc. The PDA concept was actually conceived more than a decade ago. But until recently, the level of integration wasn't high enough to pack all of the necessary functionality into a handheld-size device. Both the Apple and Eo devices employ 32-bit RISC CPUs: the Advanced RISC Machine (ARM) chip on the Newton and the AT&T Hobbit on the Personal Communicator.

Both the ARM and AT&T processors are designed for embedded systems, including PDAs, data-communication devices, and even some automotive applications. While limited in terms of the operating systems and applications they can run, these microprocessors offer low pin counts, small footprints, and consume very little power thanks to their fully static design.

Embedded systems have also benefited from the continuing escalation of CPU compute power. This performance acceleration aids embedded designers in creating systems that deliver more throughput for only a modest cost increase. Consider a laser printer that's used for electronic publishing. Today's RISC processors deliver 11 to 20 pages/min. on a printer that sells for $2000. This was unheard of as recently as a few years ago.

At the high end, RISC architectures help the printers pump out better than 50 pages/min. on printers costing around $20,000. Printers of this caliber were selling for six figures. In both cases, the embedded system employs one board that can be built for as little as $200 at the low end, and $2000 to $5000 at the mid-range and high end.

One of the principle effects of the microprocessor revolution has been to shift the dividing line between high-end multichip solutions and single-chip solutions.

Another dramatic breakthrough in the processing revolution relates to the development tools themselves. Previously, designers invariably wrote code for their embedded applications in assembly language to maximize performance. But such speed has come at the expense of portability and readability.

With increasing processor speeds, performance has become less of an issue, opening the door to higher-level languages like C and C++. Compilers for these languages have improved considerably over the last few years, with a performance overhead of only about 5%. Where that percentage is too high, designers can take advantage of analysis software to pinpoint any modules causing bottlenecks. Then those modules can be hand-coded in assembly language.

One of the biggest advantages of higher-level languages is their comparatively easy maintenance. Programmers are notorious for their lack of code documentation, a habit that can be disastrous with assembly-language programming. While C isn't exactly the most structured language in existence, it's considerably more self-documenting than assembly language, and thus can eliminate many headaches.

Embedded systems make strong candidates for object-oriented programming languages. Embedded designs are inherently modular and can be easily represented by a set of objects. C++ in particular is becoming the default language for such development.

Portability is one benefit gained by using high-level languages. Embedded designers face a market that's still in quite a state of flux—the CPU that was originally for a project chosen may not supply the solution needed for a particular marketplace. Therefore, consider the advantages of moving from, for example, a CISC to a RISC processor architecture. Because a RISC core has a lower transistor count than its CISC equivalent, designers can increase the functionality of the die, by adding such components as direct memory access, counter timers, I/O, and more.

The ability to quickly migrate an embedded design from one processor to another helps designers reach the ultimate goal—to make a product faster, yet cheaper. The only way to perform such magic may be to change processors. Or, if the base language is portable, simple recompilation can replace months of recoding.

Using off-the-shelf CPUs in embedded applications has also paved the way for smarter development tools. It wasn't that long ago when designers often worked from two systems, one with the source code and the other containing the block diagram and intelligence to check the logic. Today, these two displays are connected, and can access the same set of development tools. In many cases, most of the code is generated directly from the toolset, rather than created by hand.

Faster processors have also hastened the trend toward third-party, real-time kernels from companies like Lynx Real Time Systems, Wind River Systems, and Ready Systems. Maintain-

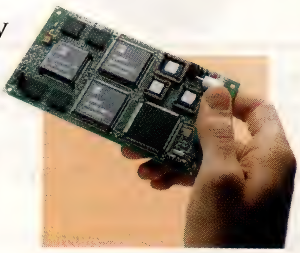
AT $4,895,
THE NEXT LEAP IN DEBUGGING
IS SO HUGE, IT'S TINY.

Get a full-featured CodeTAP® emulator for as little as $4,895, including powerful debugging software.

Take the next leap in embedded systems debugging and discover the surprisingly small *sizes* and *prices* of our innovative CodeTAP emulators. They put the performance and functionality of full-scale emulators into a probe tip. And right now you can buy one with debugging software for as little as $4,895. So you can afford to equip all your engineers with their own emulator.

CodeTAP and new CodeTAP-XA emulators may be tiny, but they pack a lot of power to help you find problems fast. We offer models for popular Intel and Motorola micros, providing an assortment of impressive features such as: ❧ Real-time, full-speed emulation ❧ Hardware and software breakpoints ❧ Sequential event system ❧ Overlay memory ❧ Statistical performance analysis ❧ Trace and intelligent trace disassembler ❧ Supports C/C++ ❧ And more.

Nobody else can offer this much power in this small a package. Because nobody else has the patented CodeTAP technology. Call today and get off the ground with the next big leap in debugging.



CodeTAP emulators support:

Intel i960 and 80C186/188, 80L186/188, 80386 families; Motorola 68332, 68331.

Applied Microsystems Corporation

For More Information on CodeTAP, and a FREE Debugging Poster, call 1-800-426-3925.

© 1993 Applied Microsystems Corp.

CIRCLE 92 FOR U.S. RESPONSE **CIRCLE 93 FOR RESPONSE OUTSIDE THE U.S.**

ing this code in-house has always been time-consuming, and the code itself has grown more complex. Generally, a team of three to five support engineers are required to support each real-time operating system. Moreover, there's all of the necessary documentation, test engineering, and updates to the operating systems to contend with. These days, real-time operating systems must handle not just two or three jobs, but as many as 50 tasks at one time, and they must be able to prioritize those tasks.

In the future, embedded-systems designers will develop even more complex applications with an even higher level of confidence.

If the same instruction set architecture is being used for the host and target designs, the software can be fully tested before building the hardware. This procedure is possible in a dissimilar environment as well, but the hardware environment must also be simulated, causing a substantial performance penalty.

Such overhead is a particular problem when designing embedded systems for real-time applications. Consequently, designers employ in-circuit emulators to try to guarantee that the clock frequencies resemble those found in real-world CPUs. With a common host and target, the simulation engine needs to emulate just 100,000 or so transistors—rather than three million for different or dissimilar hosts and targets—in real time. Typically, microprocessor simulations run at a rate of about 3000 instructions/s on a Sparcstation 10 workstation and, using specialized hardware, can go up to a maximum of 700,000 instructions/s.

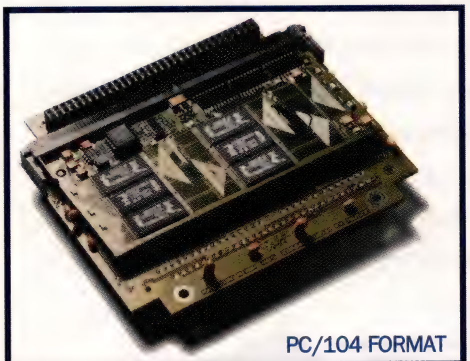
In the future, embedded-systems designers will develop even more complex applications with an even higher confidence level. Voice-response interfaces combined with built-in expert systems will also increase productivity. Expert systems could potentially produce a design without the developer ever picking up a mouse. For example, the designer will request optimum solutions, not just diagrams, for layout on a 6-by-4-in. board. When that happens, the entire job description of the embedded-system designer will have to be rewritten.

Barry Barrett, manager of SPARC Business Development for Sun Microsystems, holds an MSEE from Plymouth Polytechnic in England.

HOW VALUABLE?

HIGHLY	CIRCLE 580
MODERATELY	CIRCLE 581
SLIGHTLY	CIRCLE 582

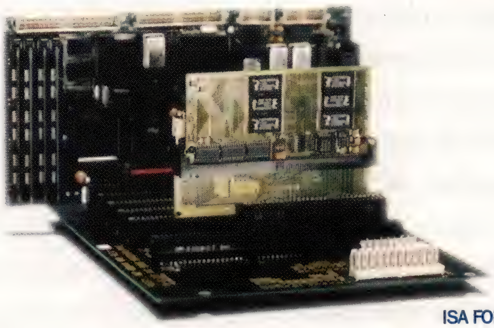
25 MByte FlasHD Memory Module



PC/104 FORMAT

"The FlasHD card allows a system to boot without mechanical drives, execute applications and write up to 25MBytes of non-volatile storage."

EMBEDDED-PC PC/104 MODULES



ISA FORMAT

- Hard Drive replacement; supports M-Systems
- Non-volatile Flash™ memory board
- Self Boot mechanism and PC auto detection
- Available with up to 25MBytes of storage
- Read/write memory system
- "Boot Block" of 256KBytes allows DOS in ROM
- Byte writable, 64KByte sector erasable
- On-board DC to DC convertor for single +5 volt operation

For a list of our international distributors, please contact our head office at:

megatel computer corp.
125 Wendell Ave.
Weston, Ont. M9N 3K9 Canada
Fax: (416) 245-6505

"For the OEM with Embedded PC Applications"

megatel®

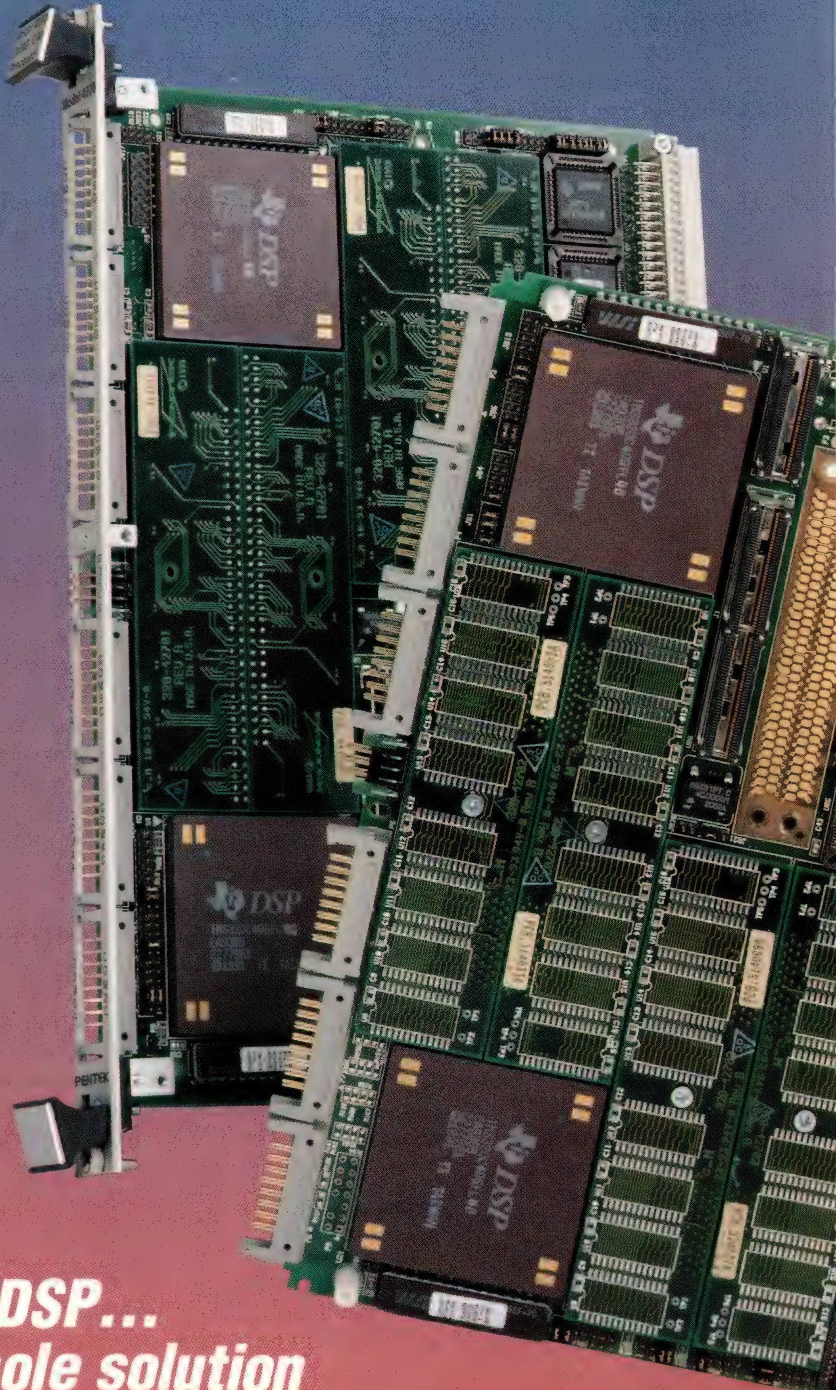
(416) 245-2953

FlasH is a trademark of Intel Corp. and Megatel is a registered trademark of Megatel Computer Corp.

CIRCLE 265 FOR U.S. RESPONSE
CIRCLE 266 FOR RESPONSE OUTSIDE THE U.S.

Pentek Quad 'C40 VME

There are other Quad 'C40 VME boards. They don't come with half the I/O, software, and DSP experience as the Pentek 4270.



Go ahead. Check out the competitors.

Then call Pentek.

Ask us about

- Data acquisition boards
- Parallel, serial and SCSI interfaces
- Telecom interfaces and digital receivers
- Our other 'C40 and 'C30 DSP processors
- Our SwiftTools™ development environment, SwiftNet™ network protocol for distributed VMEbus systems, DSP libraries, real-time OS, and device drivers.

You'll soon know about our DSP experience and what we mean when we say,

When it comes to DSP... Pentek has the whole solution

PENTEK *Innovative DSP systems*

55 Walnut Street ◆ Norwood, NJ 07648 ◆ Tel: 201-767-7100 ◆ Fax: 201-767-3994 ◆ BBS: 201-767-8733

© 1993 Pentek, Inc.

CIRCLE 144 FOR U.S. RESPONSE

CIRCLE 145 FOR RESPONSE OUTSIDE THE U.S.

SYSTEM DESIGN NEWS

PCI-based multimedia devices can be developed using a design guide that was recently approved by the Peripheral Component Interconnect Special Interest Group (PCI SIG) Steering Committee. These devices are interoperable at the component, board, and system levels. Based on Release 2.0 of the PCI specification, the guide lets designers build multimedia products ranging from low-end devices up to those of professional quality. The guide offers a set of recommendations, each geared toward a specific market. Using PCI, compressed and decompressed video steams can be transmitted over the PCI bus, while a frame buffer displays graphics on the screen. The PCI specification was defined to allow up to four functions to be integrated on one add-in card. Using a PCI-to-PCI bridge, a secondary bus can be created for expansion. With the secondary bus dedicated to video, latencies less than 3 μs are defined with a peak bandwidth of 264 Mbytes/s. The PCI SIG is also evaluating a card-top connector to extend the secondary bus. Call the PCI SIG at (503) 696-6111.

Release 2.0 of the VESA local bus (VL-Bus) standard, which adds features and maintains backward compatibility with the 1.0 release, was recently approved. New features include 64-bit device support and connector timing speeds up to 50 MHz. The new specification directly supports 64-bit microprocessors, such as Intel's Pentium. The 64-bit expansion lets systems with such processors effectively double the available local bus bandwidth while still allowing existing 32-bit VL-Bus boards to coexist in the system. The 64-bit extension employs the current 32-bit connector by multiplexing the added 32 address and data bits. By increasing the connector timing-speed support to 50 MHz, the stability of connectors and components is improved. In addition, the 50-MHz operation allows data rates up to 266 Mbytes/s. Other new features include CPU write-back caching and support for signal bridges and mezzanine-bus architectures.

Three Plug and Play development kits, created by Intel's Architecture Labs, are available to assist system and add-in board developers in making PCs easier to set up and configure. Plug and Play describes a class of PC add-in cards that can be easily installed in a system without having to set any jumpers or running any special configuration utilities. The first kit comes with a DOS driver that automatically detects and configures add-in cards; interface libraries that give device drivers easy access to configuration information; a configuration utility that helps users handle cards not compatible with the Plug and Play standard; and reference manuals. The second kit adds BIOS software that automatically detects and configures PCI and Plug and Play add-in cards. The software is available in source-code form, so peripheral manufactures can integrate the code into their existing designs. The last kit includes a fully functional audio Plug and Play reference board, a Windows 3.1 virtual device driver, diagnostics, and schematics. For more information, call Intel at (800) 548-4725.

A full-motion video processor, the VIP (video integration processor), combines image scaling, pixel dithering, and color-space conversion all on a single CMOS chip. Developed by IBM Corp.'s Networking Systems Div., Research Triangle Park, N.C., the chip provides crisp, color-rich images in scalable windows. It can produce two live full-screen videos on a personal computer or video-conferencing system at 30 frames/s, and provides a significant boost in image handling versus other video image processors. Scaling of an image can be done to any size from 1% of the original to 400% of the original image without artifacts thanks to a highly-sophisticated scaling algorithm on the chip. Furthermore, the chip can process a TV-like RGB or YUV data stream and send the data to the computer's memory for subsequent manipulation and display. The TV data stream can be transformed into RGB 24, 16 or 8 screen formats, with the proprietary dithering algorithms improving the quality of the RGB 8 and 16 signal formats. Contact Len Felton at IBM at (919) 543-5221.

▼ HALF-SIZE SBC ADDS PC/104 PORT

Designed for passive-backplane applications, the ICH-486SLC is a PC/AT-compatible single-board computer (SBC) that fills half the space of competitive products. For increased functionality, the board is built with a PC/104 expansion port, making it suitable for embedded applications. The on-board 33-MHz 486SLC microprocessor contains 1 kbyte of cache memory. Moreover, the board has room for 16 Mbytes of DRAM. There's also a parallel and two serial ports, floppy- and hard-disk drive interfaces, an on-board speaker, and a watchdog timer.

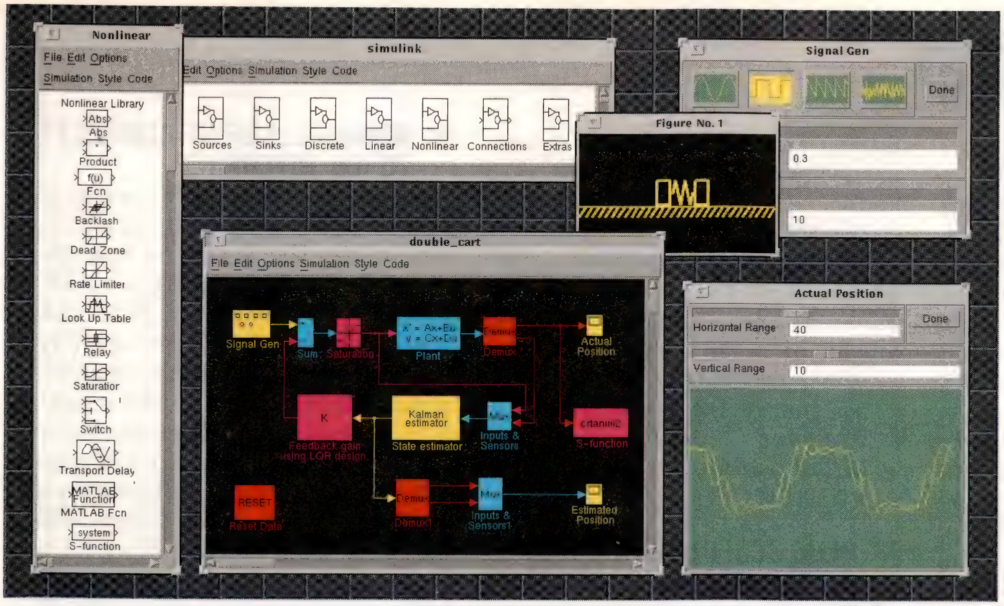
The board comes with customized BIOS that permits booting with or without a keyboard, a feature needed for many embedded applications. A CMOS design lowers the power draw to just 7 W. Available now, the ICH-486SLC SBC is priced at $495 with documentation. Large-quantity discounts are available.

Micro Computer Specialists Inc.
2598 Fortune Way
Vista, CA 92083
(619) 598-2177
▶CIRCLE 900

▼ CDPD SYSTEM WORKS WITH PORTABLE COMPUTERS

The Ubiquity 2000 is a cellular-digital-packet-data (CDPD) communications system for use with PC-compatible mobile computers. Easily attached to the portable PC, the Ubiquity 2000 self-powered system offers access to many communications technologies, including CDPD circuit-switched cellular or wire-line data, voice, or fax. Users can attach a handset to the device to make out-going telephone calls, dialing from the keyboard or through software. The unit is completely compatible with DOS and Windows. Available sometime in the first quarter, the Ubiquity 2000 costs $1595. That includes the communications applications, DOS and Windows drivers, cables to connect to the computer and to a public telephone, an ac adapter, a user manual, and a mounting holster.

Pacific Communication Sciences
10075 Barnes Canyon Rd.
San Diego, CA 92121
(619) 535-9500
▶CIRCLE 901



Simulating a system with SIMULINK: Scope block and MATLAB animation window show results while the simulation is running. You can change parameters during a simulation to do "what if" analyses.

It's time to go nonlinear with SIMULINK®.

SIMULINK gives you a powerful interactive workbench to model, analyze, and simulate physical and mathematical systems. SIMULINK allows you to rapidly model the behavior of complex systems like regional power grids, satellite controllers, aircraft, robotic systems and biochemical processes.

Create Models Graphically

With SIMULINK you can model a dynamic system quickly and easily. Just drag and drop icons into block diagrams — there's no need to write a single line of code.

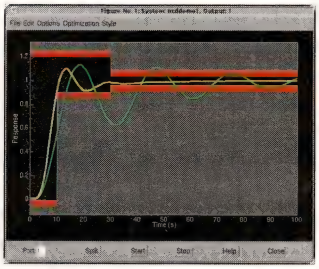
SIMULINK provides over 200 built-in block types from which to build your models. You can also design your own blocks, complete with custom icons. Plus, blocks can be grouped to create a model hierarchy.

Extensive Model Types

To model a complete range of system behaviors, you can combine linear and nonlinear elements defined in discrete-time, continuous-time or as a hybrid system.

Interactive Simulation

SIMULINK makes it easy to run simulations and monitor results interactively. Just attach signal source blocks to generate input signals and oscilloscope blocks to monitor outputs. For "what if" analyses, change parameter settings while the simulation is running; you see the changed outputs immediately. And with SIMULINK's trimming methods, you can find your system's equilibrium point automatically.



Graphically tune parameters in a nonlinear system with the Nonlinear Control Design Toolbox.

An Open Architecture

Because SIMULINK is based on the open and extensible architecture of MATLAB®, you can easily create blocks, customize existing blocks, build custom block libraries, and use MATLAB's toolboxes including:

- *Signal Processing*
- *System Identification*
- *Control System Design*
- *Robust Control*
- *μ-Analysis and Synthesis*
- *Neural Network*
- *Optimization*
- *Nonlinear Control Design*

New Toolboxes for Nonlinear Optimization and Real-time Code

For optimizing nonlinear control systems, the new Nonlinear Control Design Toolbox gives you access to advanced time-domain-based optimization methods.

SIMULINK's new C Code Generator lets you automatically generate real-time code from models, for embedded control, rapid prototyping, and standalone simulations on your target hardware or on DSP hardware.

SIMULINK Highlights

Modeling Tools

- *Block Library with 200+ blocks*
- *Custom blocks and libraries*
- *Custom icon editor*
- *Differential equations*
- *Linear and nonlinear*
- *Discrete-time, continuous-time, and hybrid*
- *Multi-input-multi-output*
- *Hierarchical modeling*
- *Write equations in Fortran, C or MATLAB*

Simulation and Analysis

- *7 integration methods for fixed, variable-step and stiff systems*
- *Interactive simulations with live displays*
- *Batch simulations from MATLAB command line*
- *Monte Carlo simulations*
- *Access to MATLAB's extensive toolboxes*
- *Trimming: determine stable equilibrium points*
- *Linearization*

SIMULINK is available on most popular computers, including Unix workstations, MS-Windows-based personal computers, and the Macintosh.

Call 508/653-1415 for a complete brochure.

The MATH WORKS Inc.

24 Prime Park Way/Natick, MA 01760
Tel: 508/653-1415 Fax: 508/653-6284
Email info@mathworks.com

Australia:	+61-2-922-6311	Japan:	+81-3-3982-4641
Brazil:	+55-11-816-3144	Portugal:	+34-3-415-49-04
France:	+33-1-45-34-23-91	Scandinavia:	+46-8-15-30-22
Germany:	+49-89-995-9010	Spain:	+34-3-415-49-04
India:	+91-80-2-260-260	South Korea:	+82-2-517-1257
Israel:	+972-3-561-5151	Switzerland:	+41-31-998-44-11
Italy:	+39-11-24-85-332	Taiwan:	+886-2-501-8787

For Belgium, British Isles, Luxembourg, and The Netherlands call
Cambridge Control, Ltd: +44-223-421-920 **or** Rapid Data, Ltd: +44-903-821-266

MATLAB and SIMULINK are registered trademarks of The MathWorks, Inc.

CIRCLE 124 FOR U.S. RESPONSE CIRCLE 125 FOR RESPONSE OUTSIDE THE U.S.

SEE FULL-MOTION VIDEO UNDER WINDOWS

The Power!Video compression software allows playback of full-motion video that's been compressed with the TrueMotion near-broadcast-quality software algorithm, which runs under Windows 3.1. As a result, TrueMotion, which compresses each video frame independently, can be embedded into various applications within the Windows environment. Power!Video supplies the communication layer between TrueMotion and the Windows operating system. Hardware requirements include a 486-based PC, 4 Mbytes of RAM, and an ActionMedia II compatible board. The software comes with all of the necessary drivers.

Horizons Technology Inc.
3990 Ruffin Rd.
San Diego, CA 92123
(619) 292-8331
▶ CIRCLE 902

CONNECT MODEM TO EXISTING PHONE LINE

Designed for desktop computers, the Konexx Konnector model 109 eliminates the need to add an analog phone line to employ a modem. The adapter connects to the phone's handset jack and supplies an RJ-11 connection for any modem, including line-powered models. It features automatic switching between voice and data, and supports data rates up to 14.4 kbits/s. With an ac adapter, the 109 sells for $139. A portable version, the 112, is available for $149. It offers similar features, but runs from a standard 9-V battery.

Unlimited Systems Corp. Inc.
8586 Miramar Pl.
San Diego, CA 92121
(800) 275-6354
▶ CIRCLE 903

FFS IMPROVES MEMORY-CARD PERFORMANCE

A proprietary flash file system (FFS), called TrueFFS, saves memory space and improves the performance of standard PCMCIA cards and other flash memories. TrueFFS lowers the file system overhead to just 19 kbytes. It also features read and write speeds of 2 Mbytes/s and 100% emulation of standard hard-disk drive operations. The system is completely transparent to the end user as it resides between the operating system and the PCMCIA card and socket services. TrueFFS can increase the flash-memory cards' reliability because it spreads write operations throughout the available memory area, causing an even amount of "wear" on the memory.

M-Systems Flash Disk Pioneers
556 Mowry Ave., Suite 103
Fremont, CA 94536
(510) 505-9081
▶ CIRCLE 904

PLUG SCSI PERIPHERALS INTO PORTABLE COMPUTERS

SCSI-based peripherals can be used with portable computers by employing the SCSI2GO PCMCIA card. The 16-bit card fits the PCMCIA Type 2 form factor. Data rates of up to 10 Mbytes/s can be handled. The interface cable possesses a locking PCMCIA card connector on one end and a 50-pin SCSI-2 connector on the other. While operating, the card consumes just 210 mW. When not in use, the card enters a low-power sleep mode. Available now, the SCSI2GO card comes in a kit with a cable and application-interface software. The PCMCIA device goes for $329; for an extra $60, Corel SCSI software is added.

Future Domain Corp.
2801 McGaw Ave.
Irvine, CA 92714
(714) 253-0400
▶ CIRCLE 905

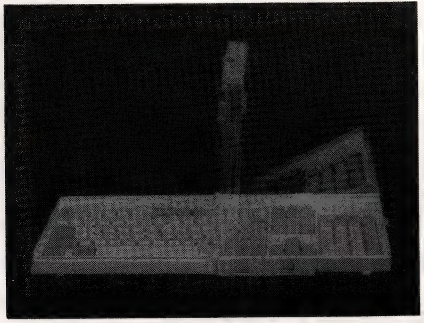
BERNOULLI DRIVE CONNECTS TO IDE INTERFACE

Bernoulli drives typically connect to PCs though a SCSI port, which requires using a SCSI adapter that connects to the PC's ISA bus. Now, thanks to the Bernoulli MultiDisk 150, the drive can be plugged directly into an IDE interface. The system, which fits right into a half-height 5.25-in. drive bay, derives its power from the host system's power supply. The drive can be configured as a second slave drive to an internal IDE hard-disk drive. The 150-Mbyte model maintains read and write compatibility with the older, lower-capacity drives. It also offers an effective access time of 18 ms and a 256-kbyte read-write cache buffer. The IDE Bernoulli MultiDisk 150 is priced at $589. That price includes the installation software, drivers, and various utilities.

Iomega Corp.
1821 West 4000 South
Roy, UT 84067
(801) 778-1000
▶ CIRCLE 906

KEYBOARD FOLDS IN HALF WHEN NOT IN USE

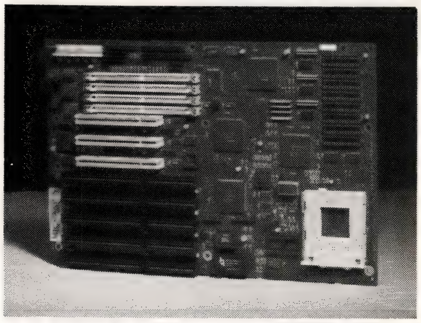
A novel full-size PC-compatible keyboard can be stored in half the space of a typical 101-key keyboard simply because it folds in half when it's not being used. The KFB-01 measures 10 by 6.75 by 2.25 in. when folded and offers a full 4-mm key travel and a 10-million-operation key-life expectancy on its mechanical click switches. In addition, a locking mechanism keeps unwanted users from typing on the keyboard. The KFB-01 folding keyboard, priced at $99, is available now.



Golden Pacific Electronics Inc.
560 South Melrose St.
Placentia, CA 92670
(714) 993-6970
▶ CIRCLE 907

▼ PENTIUM AND 486DX2 BOARDS EMPLOY PCI

Two PC motherboards are based on the PCI local-bus standard. The M4P is based on a 486 microprocessor, while the M5Pi is built with a Pentium CPU. The boards contain two 32-bit PCI expansion slots, one shared PCI/ISA expansion slot, and five ISA slots (four on the M5Pi). The PCI bus offers a 32- or 64-bit data path for communications between the processor and the peripherals that require the high bandwidth.



Each board offers an upgrade path using the OverDrive technology. Users simply plug a new processor into the empty socket. In addition, the boards hold up to 256 kbytes of secondary write-back or write-through cache memory and up to 128 Mbytes of system RAM. The baby AT footprint lets the boards fit desktop or tower configurations. The M4P, with a 66-MHz 486DX2 processor and 256 kbytes of cache memory, sells for $765 in large quantities. The 60-MHz Pentium model, also with 256 kbytes of cache, costs $1284 in similar quantities. A 66-MHz Pentium version is also offered. All are available now.

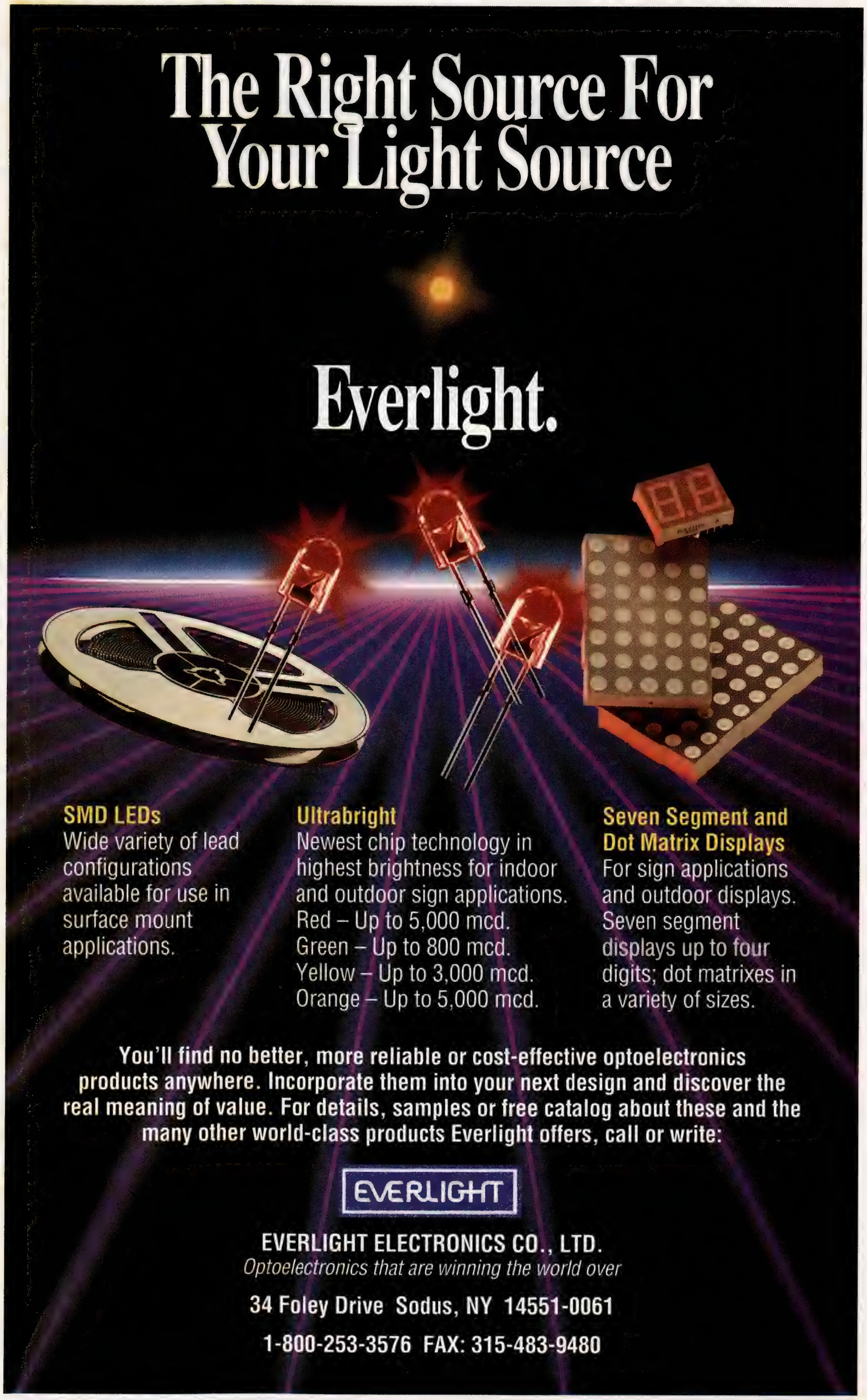
Micronics Computers Inc.
232 E. Warren Ave.
Fremont, CA 94539
(510) 651-2300
▶ **CIRCLE 908**

▼ DDS-2 DAT DRIVE HOLDS 8 GBYTES

Featuring a storage capacity of 8 Gbytes, the 3400DX digital-audio-tape (DAT) drive is built with a unique mechanical design and an advanced software algorithm. The DDS-2-compatible drive fits a standard 3.5-in. form factor. Data compression increases the drive's storage capability to 16 Gbytes. It can transfer data at 732 kbytes/s, sufficient for backup and retrieval applications.

The 3400DX DAT drive is designed to handle a thin 120-m metal-particle tape. This results from a windowless drum design that supplies better tape contact with the read-write heads than do conventional drives. The architecture also adds low-friction flanged roller tape guides and a tension buffer arm in the tape path to eliminate stress on the tape during the frequent starts and stops. Available now, the 3400DX DAT drive sells for $1650. Large-quantity discounts are available.

WangDAT Inc.
41 Moreland Rd.
Simi Valley, CA 93065
(805) 583-5255
▶ **CIRCLE 909**



The Right Source For Your Light Source

Everlight.

SMD LEDs
Wide variety of lead configurations available for use in surface mount applications.

Ultrabright
Newest chip technology in highest brightness for indoor and outdoor sign applications.
Red – Up to 5,000 mcd.
Green – Up to 800 mcd.
Yellow – Up to 3,000 mcd.
Orange – Up to 5,000 mcd.

Seven Segment and Dot Matrix Displays
For sign applications and outdoor displays. Seven segment displays up to four digits; dot matrixes in a variety of sizes.

You'll find no better, more reliable or cost-effective optoelectronics products anywhere. Incorporate them into your next design and discover the real meaning of value. For details, samples or free catalog about these and the many other world-class products Everlight offers, call or write:

EVERLIGHT

EVERLIGHT ELECTRONICS CO., LTD.
Optoelectronics that are winning the world over
34 Foley Drive Sodus, NY 14551-0061
1-800-253-3576 FAX: 315-483-9480

CIRCLE 108 FOR U.S. RESPONSE
CIRCLE 109 FOR RESPONSE OUTSIDE THE U.S.

▼ 4-GBYTE DISK ARRAY FITS IN 5.25-IN. BAY

A hardware-based disk-array subsystem comes in capacities ranging from 1 to 4 Gbytes, and can transfer data at 10 Mbytes/s. Called the Dorado, the fault-tolerant subsystem can handle platforms that must constantly stay on line. It employs five 3.5-in. hard-disk drives mounted in a compact package that can be integrated into a desktop or tower case. The package fits a 5.25-in., full-height form factor. Fault tolerance is maintained by a proprietary recording technique. As a result, when one drive fails, the data on that drive can be recreated by the remaining drives. The arrays can be configured as RAID Level 3 or 5 devices, depending on the application. Prices for the Dorado series start at $5000.

Allodyne Inc.
5317 Randall Pl.
Fremont, CA 94538
(510) 770-1101
▶ CIRCLE 910

▼ POWER SUPPLY RESIDES IN EXTERNAL TAPE DRIVES

A family of parallel-port tape drives comes with a built-in power supply, eliminating the clunky power converter on the ac adapter for conventional parallel-port devices. An integrated auto-sensing and -ranging capability automatically adjusts the drives to match the differences in international power requirements. The parallel-port connector features a pass-through port that can connect to a printer of another parallel-port device. The drives are compatible with the DC2000 minicartridge standard. OEM and end-user versions are available now. Prices start at $359.

Conner Peripherals Inc.
Tape Products Group
1650 Sunflower Ave.
Costa Mesa, CA 92626
(714) 966-5580
▶ CIRCLE 911

▼ PLUG IDE HARD DRIVES INTO PCI BUS

The sIDE-2/PCI is a 32-bit IDE controller for PCI-based computers. It can transfer up to 10 Mbytes/s through the IDE interface. The board supports two IDE-compatible hard-disk drives. Installation software and cables simplify its configuration. The sIDE-2/PCI, which will ship sometime in the first quarter, is priced at $55. A VL-Bus version is also available.

Acculogic Inc.
13715 Altron Pkwy.
Irvine, CA 92718
(714) 454-2441
▶ CIRCLE 912

For Micros, Call Us When Your Chips Are Down.

It's a fact that we're a great second source for micros. But there are some very good reasons to make us your first call, too.

Like consistent availability. Lots of packaging options. Microcontrollers including 68HC11, 68HC05, 8048 and 8049 families. Microprocessors such as 8085, Z80 and Z80 ASSP.

And the same high levels of quality and reliability we bring to all of our products.

To find out more, just call us.

We'll make an excellent second source.

And an even better first impression.

1-800-879-4963

In Touch with Tomorrow
TOSHIBA
TOSHIBA AMERICA ELECTRONIC COMPONENTS, INC.

©1993 Toshiba America Electronic Components, Inc. MPU-93-049

CIRCLE 158 FOR U.S. RESPONSE
CIRCLE 159 FOR RESPONSE OUTSIDE THE U.S.

APRIL 19-21, 1994 ◆ HYNES CONVENTION CENTER ◆ BOSTON, MA

THE EMBEDDED SYSTEMS CONFERENCE IS COMING TO BOSTON

DESTINATION: BOSTON

The world's largest conference and exhibition dedicated to microprocessor- and microcontroller-based development returns East this spring for a command performance. Even if you attended our East Coast debut in Atlanta last year, Boston is where you should be April 19-21, 1994 — for the second annual **EMBEDDED SYSTEMS CONFERENCE EAST.**

WE SPEAK ALL THE LANGUAGES

The **EMBEDDED SYSTEMS CONFERENCE EAST** will help you hone the technical and project management skills required for the entire embedded process. If you want to improve design, write more efficient code, devise more effective project management strategies, and see the future of embedded development more clearly, we've got what you need.

TIPS, TRICKS, and METHODOLOGIES

Mix and match dozens of hands-on programming and methodology workshops, lectures, and tutorials on topics like these:
◆ Design methodology ◆ Debugging ◆ Languages ◆ Networks ◆ Chip programming ◆ Hardware interfacing ◆ Digital signal processing ◆ Project management ◆ Fuzzy logic

EXPERTS' INSIGHTS FIRSTHAND

Get direct access to dozens of today's top experts in embedded development, including:

◆ Paul Ward and Stephen Mellor, creators of the Ward-Mellor methodologies that brought CASE to real-time embedded systems
◆ Larry Constantine, co-author of the definitive text, Structured Design
◆ Plus many more

TARGETED PRODUCTS AND SERVICES

See the largest dedicated exhibition of embedded development tools and utilities, talk to representatives from more than 100 leading companies, and try the latest in:
◆ compilers/cross compilers ◆ in-circuit emulators ◆ logic analyzers ◆ single board computers ◆ microprocessors/ microcontrollers ◆ debugging tools ◆ real-time operating systems ◆ cross assemblers ◆ simulators
◆ and more . . .

MAIL OR FAX TO:

EMBEDDED SYSTEMS CONFERENCE EAST *
Miller Freeman, Inc.
Attn: Julie Ann Lee
600 Harrison Street
San Francisco, CA 94107 USA

FAX (415) 905-2220 OR CALL (415) 905-2354

SEND ME THE DETAILS FAST ON THE EMBEDDED SYSTEMS CONFERENCE EAST

April 19-21, 1994, Hynes Convention Center, Boston, MA

I'm interested in:

☐ Attending ☐ Exhibiting

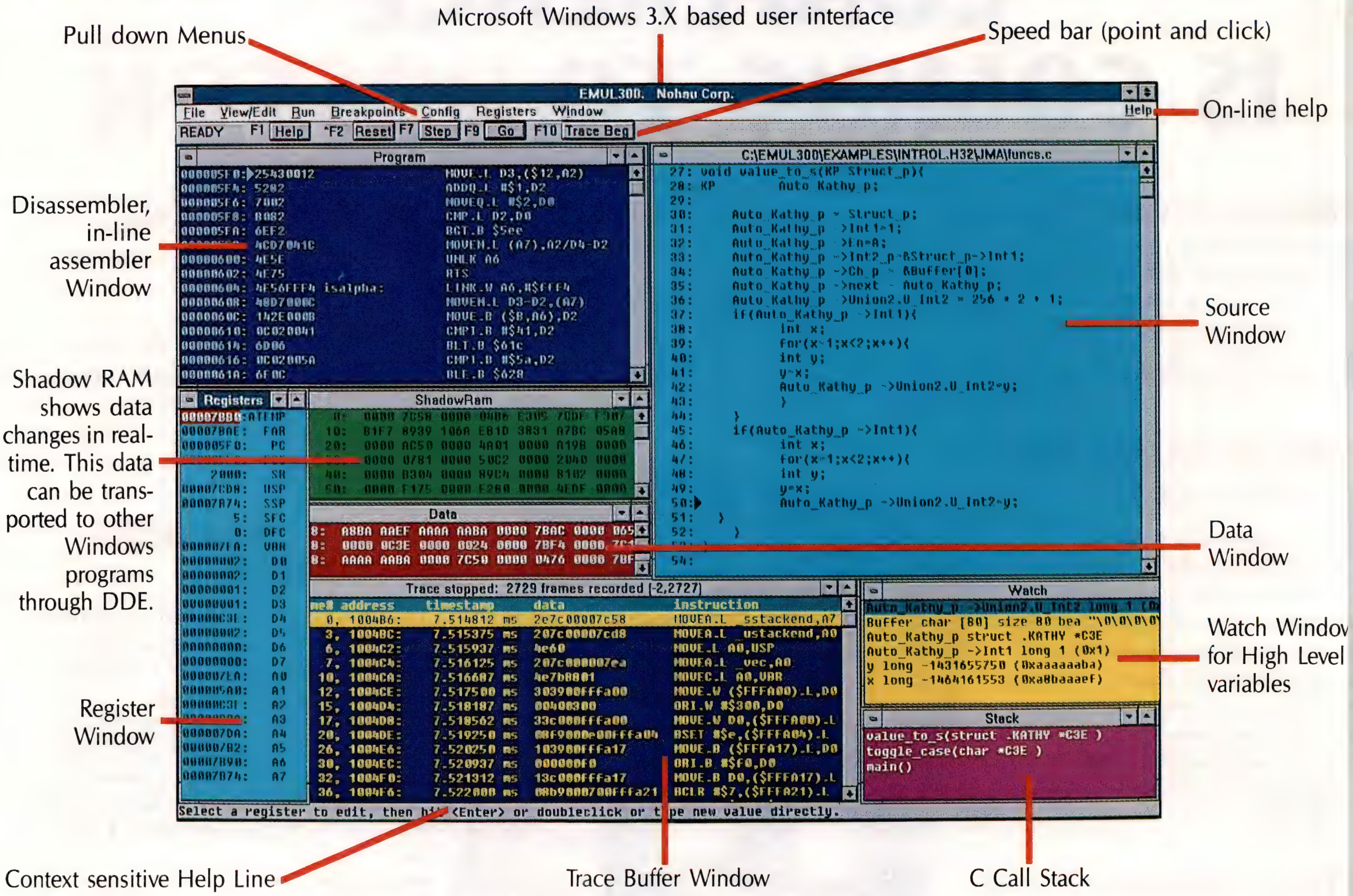
Name ____________________
Title ____________________
Company ____________________
Address ____________________
____
City ____________________
State __________ Zip __________
Phone ____________________
Fax ____________________ EED4

CIRCLE 106 FOR U.S. RESPONSE

CIRCLE 107 FOR RESPONSE OUTSIDE THE U.S.

In-Circuit Emulators and Background Debuggers

68300 68HC16


Pull down Menus
Microsoft Windows 3.X based user interface
Speed bar (point and click)
On-line help
Disassembler, in-line assembler Window
Source Window
Shadow RAM shows data changes in real-time. This data can be transported to other Windows programs through DDE.
Data Window
Watch Window for High Level variables
Register Window
Context sensitive Help Line
Trace Buffer Window
C Call Stack
EMUL300. Nohau Corp.
File
View/Edit
Run
Breakpoints
Config
Registers
Window
Help
READY
F1 Help
^F2 Reset
F7 Step
F9 Go
F10 Trace Beg
Program
Registers
ShadowRam
Data
Watch
Stack

```
0000005F0:▶25430012            MOVE.L D3,($12,A2)
000005F4: 5282                 ADDQ.L #$1,D2
000005F6: 7002                 MOVEQ.L #$2,D0
000005F8: B082                 CMP.L D2,D0
000005FA: 6EF2                 BGT.B $5ee
          4CD7041C             MOVEM.L (A7),A2/D4-D2
00000600: 4E5E                 UNLK A6
00000602: 4E75                 RTS
00000604: 4E56FFF4 isalpha:    LINK.W A6,#$FFF4
00000608: 48D7000C             MOVEM.L D3-D2,(A7)
0000060C: 142E0008             MOVE.B ($8,A6),D2
00000610: 0C020041             CMPI.B #$41,D2
00000614: 6D06                 BLT.B $61c
00000616: 0C02005A             CMPI.B #$5a,D2
0000061A: 6F0C                 BLE.B $628
```

```
C:\EMUL300\EXAMPLES\INTROL.H32\JMA\funcs.c
void value_to_s(KP Struct_p){
KP          Auto_Kathy_p;

    Auto_Kathy_p = Struct_p;
    Auto_Kathy_p ->Int1=1;
    Auto_Kathy_p ->En=A;
    Auto_Kathy_p ->Int2_p=&Struct_p->Int1;
    Auto_Kathy_p ->Ch_p = &Buffer[0];
    Auto_Kathy_p ->next = Auto_Kathy_p;
    Auto_Kathy_p ->Union2.U_Int2 = 256 * 2 + 1;
    if(Auto_Kathy_p ->Int1){
          int x;
          for(x=1;x<2;x++){
          int y;
          y=x;
          Auto_Kathy_p ->Union2.U_Int2=y;
          }
    }
    if(Auto_Kathy_p ->Int1){
          int x;
          for(x=1;x<2;x++){
          int y;
          y=x;
▶         Auto_Kathy_p ->Union2.U_Int2=y;
  }
    }
```

```
00007BB6:ATEMP
00007BAE:   FAR
000005F0:    PC
     2000:    SR
00007CD8:   USP
00007A74:   SSP
        5:   SFC
        0:   DFC
000007EA:   VBR
00000002:    D0
00000002:    D1
00000001:    D2
00000001:    D3
00000C3E:    D4
00000002:    D5
00000000:    D6
00000000:    D7
000007EA:    A0
000005A0:    A1
00000C3E:    A2
        :    A3
000007DA:    A4
000007B2:    A5
00007B90:    A6
00007B74:    A7
```

```
 0:  0000 7C58 0000 0406 E305 7CDE F307
10:  B1F7 8939 106A E81D 3831 A7BC 05A8
20:  0000 AC50 0000 4A01 0000 A198 0000
     0000 0781 0000 50C2 0000 204D 0000
40:  0000 B304 0000 89C4 0000 8102 0000
50:  0000 F175 0000 F280 0000 4EDF 0000
```

```
8:  A8BA AAEF AAAA AABA 0000 7BAC 0000 065
8:  0000 0C3E 0000 0024 0000 7BF4 0000 7C1
8:  AAAA AABA 0000 7C58 0000 0476 0000 7BF
```

```
Trace stopped: 2729 frames recorded (-2,2727)
me# address   timestamp      data                instruction
 0, 1004B6:   7.514812 ms    2e7c00007c58        MOVEA.L  sstackend,A7
 3, 1004BC:   7.515375 ms    207c00007cd8        MOVEA.L  ustackend,A0
 6, 1004C2:   7.515937 ms    4e60                MOVE.L A0,USP
 7, 1004C4:   7.516125 ms    207c000007ea        MOVEA.L  _vec,A0
10, 1004CA:   7.516687 ms    4e7b0801            MOVEC.L A0,VBR
12, 1004CE:   7.517500 ms    303900fffa00        MOVE.W ($FFFA00).L,D0
15, 1004D4:   7.518187 ms    00400300            ORI.W #$300,D0
17, 1004D8:   7.518562 ms    33c000fffa00        MOVE.W D0,($FFFA00).L
20, 1004DE:   7.519250 ms    08f9000e00fffa04    BSET #$e,($FFFA04).L
26, 1004E6:   7.520250 ms    103900fffa17        MOVE.B ($FFFA17).L,D0
30, 1004EC:   7.520937 ms    000000f0            ORI.B #$F0,D0
32, 1004F0:   7.521312 ms    13c000fffa17        MOVE.B D0,($FFFA17).L
36, 1004F6:   7.522000 ms    08b9000700fffa21    BCLR #$7,($FFFA21).L
```

```
Auto_Kathy_p ->Union2.U_Int2 long 1 (0x
Buffer char [80] size 80 bea "\0\0\0\0
Auto_Kathy_p struct .KATHY *C3E
Auto_Kathy_p ->Int1 long 1 (0x1)
y long -1431655750 (0xaaaaaaba)
x long -1464161553 (0xa8baaaef)
```

```
value_to_s(struct .KATHY *C3E )
toggle_case(char *C3E )
main()
```

```
Select a register to edit, then hit <Enter> or doubleclick or type new value directly.
```

FEATURES

- Supports both the 683xx and 68HC16 families.
- User Interface under Microsoft Windows.
- Modular approach: From low cost to full feature.
- Real-time emulation at maximum chip speed.
- High-Level C support with in-depth support for Intermetrics, Introl, Microtec, Sierra and more. In-line assembler and disassembler.
- Hardware and software breakpoints.
- Up to 4 Mbytes of emulation RAM
- Trace board, up to 512k records deep, 104 bits wide, 40 bit timestamp.
- Triggering and filtering, with full pipeline decoding.
- Code Coverage. Program Performance Analysis.
- Memory Contents available in real-time (Shadow RAM).
- DDE support to transfer Shadow Ram to other Windows applications.

8051 68HC11

Full support for all derivatives.
Call for FREE demo disk.

To learn more, *please call (408) 866-1820 for a FREE Demo Disk. Or call our 24-hour Information Center at (408) 378-2912 for information via your fax.*

nohau
CORPORATION

51 E. Campbell Avenue
Campbell, CA 95008
Tel (408) 866-1820
Fax (408) 378-7869

Australia (02) 654 1873, Austria 0277 20-0, Benelux (01858) 16133, Brazil (011)-458-8755, Canada 1-514 689-5889, Czechoslovakia 0202-2683, Denmark 43 44 60 10, Finland 90-4526-21, France (1) 69 41 28 01, Germany 08131-25083, Great Britain 0962-733140, Greece (01) 862 9901, Hungary (1) 163 7461, India (0212) 422164, Israel (03) 491202, Italy (011) 771 00 10, Korea (032) 860-5470, New Zealand 09-3092464, Norway 02-67 40 20, Portugal 01-80 95 18, Romania 961-30078, Singapore +65 749-0870, Slovenia 061-445-526, S. Africa (021) 23-4943, Spain (93) 217 23 40, Sweden 040-92 24 25, Switzerland 01-740 41 05, Taiwan 02 7640215, Thailand (02) 281-9596.

CIRCLE 216 FOR U.S. RESPONSE   CIRCLE 217 FOR RESPONSE OUTSIDE THE U.S.

PRODUCTS NEWSLETTER

FDDI CHIP SET TRIMS PRICE BY 40%

By lowering its price for its FDDI chip set, Motorola Inc., Austin, Texas, expects that FDDI board manufacturers will be able to drop their board prices by close to 25%. The new price for the two-chip set is now $59.95 per set in lots of 10,000 sets, which could translate to board-level prices of less than $750 for a 125-Mbit/s FDDI adapter by late 1994. With the ability to support both fiber and copper twisted-pair cables, the chip set consists of the 68840 integrated FDDI chip and the 68836 FDDI clock generator. An optional chip, the 68834 cipher circuit, gives designers an easy-to-implement solution for the emerging ANSI TP-PMD standard. The chips are now available in surface-mount packages. Contact Mike Shoemake, (512) 891-3823. *DB* CIRCLE 601

PRICE DROPS FOR FPGAS EASE MILITARY BUDGETS

By moving its antifuse-based FPGAs to a 1-μm CMOS process, Actel Corp., Sunnyvale, Calif., has improved yield and reduce chip prices by about 10% for its military-grade ACT 1 and 2 FPGA families. The lower prices should make the arrays even more attractive to military system designers. The arrays were well received by defense contractors because programmed devices are nonvolatile, are inherently radiation hard, and afford a very good level of design security (it's difficult to detect a programmed antifuse). The ACT families offer complexities from 1200 to 8000 gates and meet MIL-STD-883B requirements. ACT 1 military-temp-range devices are $93 to $150 each lots of in 1000 units; ACT 2 devices range are $229 to $378 each. For 883B-qualified devices, ACT 1 prices are $150 to $244 each; ACT 2 chips costs $434 to $755 each. Contact Tom Todd, (408) 739-1010. *DB* CIRCLE 602

ONE-CHIP ENDEC TRIMS NETWORK ADAPTER COST

Combining the Manchester code converter and a 10Base-T transceiver on one chip, the 80C24 from Seeq Technology, reduces the complexity of the front-end of Ethernet adapters. The chip eliminates the need for costly external filters and common-mode chokes, while improving the output signal quality of the front-end. Also included on the chip are some system interface enhancements—STP/UTP selection and an Autoport AUI/TP capability. This is the first encoder/decoder chip to use coded link pulses to implement a proprietary AutoDuplex mode that allows 10Base-T Ethernet devices to transmit and receive simultaneously. By using AutoDuplex, the 80C24 combined with Seeq's 80C03 and 80C04 Ethernet controllers increases the bandwidth of a standard 10-Mbits/s twisted-pair Ethernet to 20 Mbits/s. Samples of the ENDEC are immediately available in 44-lead PLCCs. In lots of 10,000 units, the ENDEC and N'Core auto-full duplex controller cost less than $10/set. Contact Samba Murthy, (510) 226-7400. *DB* CIRCLE 603

READY WORKS WITH AMD 29K FAMILY

Ready Systems, Sunnyvale, Calif., has been awarded a contract to support with its real-time operating system and cross-development tools the 29K and Am386 E series processors from Advanced Micro Devices, also of Sunnyvale. Spectra, Ready's open cross-development backplane, supplies AMD users with a wide variety of target connections independent of the runtime system and multiple open interfaces for integrating existing software applications and tools. Version 3.0 of the VRTX operating system includes the VRTXsa OS, VRTX32 kernel, and Streams-based networking components. For more information, phone (408) 370-2600. *SVT* CIRCLE 604

CHIP PUTS INTERACTION AND MULTIMEDIA ON TV

End users can get interactive and multimedia services through a broadband television network using the Malibu, which combines a graphics and memory-controller chip in a TV-top terminal. Malibu is designed by Kaleida Labs Inc., Mountain View, Calif., and manufactured by Motorola, Phoenix, Ariz. The TV-top device will be produced by Scientific-Atlanta Inc., Norcross, Ga. Malibu is suited for operation with PowerPC-based systems. It supplies the functionality needed to create high-resolution text and 2D and 3D animation and graphics. In addition, the part is built to MPEG standards by permitting direct connection to various audio and video decoders. The three companies will develop interface software for networks and media servers. For more information, contact Kaleida Labs at (415) 966-0764, Motorola at (602) 952-3856, or Scientific Atlanta at (404) 903-5542. *RN* CIRCLE 605

Edited by Clifford Meth

"I'm a vice president because I sold 22,000 gizmos this year. How'd you become a v.p.?"
"I made a great deal on the 200,000 gizmos you didn't sell last year."

Turn your **excess inventory** into a tax break and help send needy **kids to college**.

Call for your **free guide** to learn how donating your slow moving inventory can mean a generous **TAX WRITE OFF** for your company.

Call **708-690-0010**

EAL

P. O. Box 3021, Glen Ellyn, IL 60138 FAX (708) 690-0565

Excess inventory today...student opportunity tomorrow

ABSOLUTE VALUE

High performance LCR meters from SRS. Absolutely lowest price. Starting at $995.

Value. It means getting your money's worth.

For passive component measurement, the new standards in value are the SR720/715 LCR meters from SRS. Meters that offer significant advantages in performance and price. Performance like .05% basic accuracy, 100 kHz test frequency, and fast measurement rates up to 20 per second. Features like a built in Kelvin fixture, averaging, binning and limits, stored setups, and quick calibration. With the standard RS232 and optional GPIB and Handler interfaces, the SR720/715 solves your incoming inspection and automated test needs. All for a price well below what you'd expect.

The SR720/SR715. Absolute values in a complex world. Call **(408)744-9040** today for more information about the SRS advantage.

SR720 **$1995**

- 0.05% basic accuracy
- 100 Hz to 100 kHz measurement frequency
- Two 5 digit displays for simultaneous readout of major and minor parameters.
- Auto, R+Q, L+Q, C+D, C+R, Series and Parallel measurement modes
- 100 mV to 1.0 V test signals
- Internal and External Bias
- Binning and Limits for production testing and component inspection.
- RS232 interface
- GPIB and Handler interface (optional)

SR715 **$995**

Same as SR720 except:
- 0.2% basic accuracy
- 100 Hz to 10 kHz measurement frequency

SRS

STANFORD RESEARCH SYSTEMS

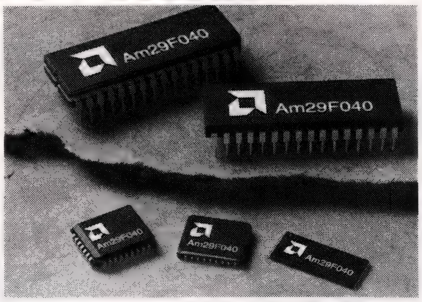
CIRCLE 175 FOR U.S. RESPONSE CIRCLE 176 FOR RESPONSE OUTSIDE THE U.S.

1290 D Reamwood Avenue, Sunnyvale, CA 94089 TEL (408)744-9040 FAX 4087449049

4-MBYTE SECTOR-ERASABLE FLASH MEMORY NEEDS ONLY 5-V SUPPLY

With the ability to operate with just a 5-V supply for both read and erase/program operations, the Am29F040 flash memory comes in 4-Mbit capacities with a 512-kword-by-8-bit organization. The sectored architecture developed by Advanced Micro Devices allows blocks of 64 kbytes to be individually erased and rewritten. This reduces programming time for small updates and the possibility of wearout. Furthermore, sector-protection logic makes it possible for users to protect selected blocks from accidental erasure/overwriting.

A suspend/resume function—not available in the company's 1-Mbit, 12-V programmable flash memory chip—was added to the 4-Mbit memory. This feature lets users stop the lengthy erase/store function so that a read request in another sector can be handled. Once the read is finished, the chip resumes the erase/store function. Designers at AMD reduced the external erase/write voltage by employing their patented negative-gate erase technology and single-transistor memory cells, which eliminates the large internal charge pumps and keeps the cell area small.



The 4-Mbit flash memories are available with 90-, 120-, and 150-ns access times. By early 1994, a 70-ns speed grade will be available. The 4-Mbit chip offers a guaranteed minimum of 100,000 write cycles per sector and is very simple to design into systems.

Housed in 32-lead DIP, PLCC, LCC, and thin small-outline packages, the 90-ns Am29F040 sells for $34.20 and $35.95 each for the PLCC and TSOP versions, respectively, in lots of 1000 unit.

***Advanced Micro Devices Inc.**, 901 Thompson Place, P.O. Box 3453, Sunnyvale, CA 94088-3453; (408) 732-2400.* CIRCLE 700

■ *DAVE BURSKY*

VIDEO PROCESSOR SCALES FILTERS, FREEZES IMAGES

A single-chip video processor for multimedia applications, the TH6200 performs real-time filtering, image sizing and clipping for digital-image information, and enables the presentation of real-time video sequences on a PC monitor under Microsoft's Windows. The chip can also "freeze" (frame-grab) images and allow them to be stored for subsequent editing. Employing a proprietary scaling algorithm, the chip provides excellent image quality for full-motion video images ranging in size from icons to full screens. When scaling inputs, the circuit adapts adjacent pixels to ensure that they match the environment rather than just removing the pixels. The chip's input can handle data fed directly from most video front-end chips, and the data output can directly drive the image port of any VGA circuit with a multimedia input port. Housed in a 68-lead PLCC, the TH6200 sells for $65 each in small quantities. An evaluation kit with drivers, documentation, and demo board costs $320. DB

Thesys Gesellschaft fur Mikroelektronik mbH, Haarbergstrasse 61, 99097 Erfurt, Germany; Kersten Heins, (49) 361-427-8350. CIRCLE 702

MIL/AERO UPGRADE #108

Futurebus+ Chipset

NATIONAL'S FUTUREBUS+ SOLUTION BEATS THE COMPETITION two chips to three. To save you time and space, our Futurebus+ data path and protocol controllers have been integrated on a single chip. It supports 32-bit local bus and 64-bit Futurebus+ address and data path widths for high-bandwidth designs. Plus, it'll keep your system running cool and fast with its low-power 80MHz BTL bus transceivers. For a free data package, here's *your* number: **1-800-NAT-SEMI, Ext. 249.**

MIL STD ★COMPLIANT★ 883

The F-14, a Mach 2+ performer, can soar even higher with Futurebus+ running its backplane.

Here today. Backed tomorrow.

National Semiconductor

©1993 National Semiconductor Corporation. All rights reserved.

COLOR MEMORY MAP CHIP SIMPLIFIES GRAPHICS

With the ability to replace as many as 27 logic and memory circuits, the MS622424 color memory-mapper circuit considerably reduces cost and system complexity. With two MS622424s operating in parallel at 70 MHz—with a combined footprint of just 1.27 sq. in. and a power consumption of 3-W, the duo forms a color look-up table for bit-mapped color displays with pixel densities from 1024-by-768 to 1280-by-1024 pixels at dot-clock rates of 140 MHz.

The chips allow designers to implement such features as virtual screens and mixed color modes (pixel throughput alternates as necessary between the color index mode and true-color RGB mode). Included on the chip is an 8-kword-by-24-bit color palette as well as all the input latches, multiplexers, output latches, write FIFO buffer, host interface logic, and a pipeline synchronization path. Each chip accepts 13 bits of information in the color index mode, 24 bits in the true-color RGB mode. In the color-index mode, the input data is used by three internal 8-kword-by-8-bit memories to look up a 24-bit color from a palette of 8192 colors out of a total of 16.7 million colors. In the true-color mode, each channel processes 8 bits of input data, which is gamma-corrected on one of three internal tables. The chips run at pixel rates of up to 70 MHz and accept video timing (synch and blanking) signals on each clock cycle, making it easy to switch between modes.

Housed in a 100-lead PQFP, the MS622424 sells for $29 each, in lots of 1000. Verilog models are available for designers wishing to perform baseline design evaluations.

Mosel-Vitelic, *3910 N. First St., San Jose, CA 95134-1501; (408) 433-6000.* **CIRCLE 703**

■ *DAVE BURSKY*

SCAN IC ALLOWS SYSTEM-WIDE TESTING

When incorporated into each pc-board, the SCAN Bridge controller IC allows boundary-scan techniques to be used for testing of the entire system, rather than just the individual boards. While remaining fully compliant with the IEEE-1149.1 boundary-scan standard, SCAN Bridge also supports multiple board testing; board, backplane, and connector testing; and system functions such as global snapshot or reset.

The SCAN Bridge architecture uses a multidrop scheme. The controller has six slot-ID inputs that can be configured for a unique address. Before issuing test instructions, the operator broadcasts the address of one or more SCAN Bridge ICs that are to process the instructions. The address is scanned into the ICs' instruction registers through the normal IEEE-1149.1 test access port.

Only boards whose addresses match the broadcast address respond. Subsequent scan operations are directed to the appropriate local boundary-scan bus and enable its test data output buffer. Once the connection with one or more boards is made, the testing proceeds in accordance with IEEE-1149.1.

The SCAN Bridge controller IC (part number SCANPSC110FSC) costs $12 each in lots of 100.

National Semiconductor Corp., *2900 Semiconductor Dr., M/S 16-300, Santa Clara, CA 95052-8090; (800) 272-9959.* **CIRCLE 704**

■ *JOHN NOVELLINO*

MIL/AERO UPGRADE #68

Our FDDI solution reroutes battle-damaged nodes, keeping this 9,600-ton Aegis Cruiser's surveillance afloat.

FDDI

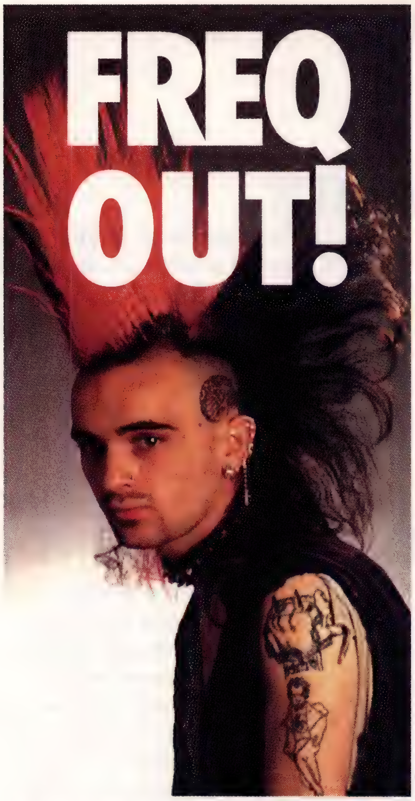
SIMPLIFY YOUR NEXT FDDI UPGRADE with the industry's first two-chip solution that's compliant to IEEE. Without a trace of EMI, it transfers data at a cool 100MB/s over an extended temperature range. It's also compatible with SAFENET and meets the commercial avionic specs for ARINC 636. Our FDDI solution is a total package—hardware, software, the works. For a free data package, here's *your* number: **1-800-NAT-SEMI, Ext. 249.**

★MIL★ QUALIFIED

Here today. Backed tomorrow.

National Semiconductor

©1993 National Semiconductor Corporation. All rights reserved.



CESIUM ACCURACY — AT 1/10 THE PRICE!

Introducing ***GPStat***™, the first low-cost GPS referenced frequency error measurement system. GPStat uses the Global Positioning System satellites to report frequency error in your clock or oscillator system.

Key features include: measures any frequency from 100KHz to 11MHz, automatic determination of popular frequencies, user selectable input frequency, 1 PPS output, optional Windows™ software.

GPStat applications include: telecommunications, metrology/calibration, oscillator evaluation, LORAN C frequency monitor replacement.

GPStat™

Odetics
PRECISION TME DIVISION
1515 South Manchester Avenue
Anaheim, California 92802-2907
(714) 758-0400 Fax (714) 758-8463
® Odetics, Inc. 1993 PTD7186EVL ENG
CIRCLE 240 FOR U.S. RESPONSE
CIRCLE 241 FOR RESPONSE OUTSIDE THE U.S.

EMBEDDED SYSTEMS HAVE RUGGED ENCLOSURES

The Embedded-150 series of industrial computers is suited for embedded, stand-alone, or mobile communications systems that require a small, rugged enclosure. Based on the Apache family of passive-backplane CPUs, the systems can deliver up to 27.5 MIPS of computing power. Onboard parallel, serial, IDE, and SCSI interfaces reduce the number of add-in cards needed. The large BIOS ROM space enables the system to operate in a diskless fashion. The rugged design permits 24-hour operation, even in hostile environments. A filtered positive-pressure air-flow design keeps contaminants out. Available CPUs range from a 25-MHz 486SX to a 66-MHz 486DX2. Prices start at about $2900. RN

Dolch Computer Systems, 372 Turquoise St., Milpitas, CA 95035; (408) 957-6575. **CIRCLE 705**

3D MOUSE LETS USERS FEEL THE ACTION

Featuring true three-dimensional control, the CyberMan 3D controller is available at a price that makes it suitable for the PC market—only $129. The device, with its tactile feel, can replace a joystick or 2D mouse. The CyberMan resembles a cross between a mouse and a joystick, but it offers six degrees of freedom instead of two. A motor built into the unit lets various gaming events be felt in addition to seen and heard. The tactile feedback requires two AA batteries or an optional ac adapter. The CyberMan is 100% compatible with existing Logitech mice, but it needs special drivers to take advantage of the 3D effects. RN

Logitech Inc., 6505 Kaiser Dr., Fremont, CA 94555; (510) 795-8500. **CIRCLE 706**

CONNECT PCMCIA DRIVE TO PORTABLE OR DESKTOP

A 1.8-in. hard-disk drive and docking bay combination lets users transport data between their portable and desktop systems. The MiniPort 128P drive fits a PCMCIA Type 3+ form factor. It measures 13-mm high. There are currently different proposals for the Type 3+ form factor, but it's generally accepted that the height will not exceed 16 mm. Hence, the 13-mm drive will have no problem meeting that specification.

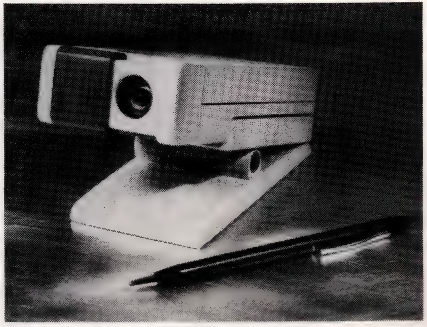
The drive stores 128 Mbytes of data in its two-platter configuration using glass media. It boasts an average seek time of 16 ms, an average latency of 6.67 ms, and a 250,000-hour MTBF. The MiniPort 128P sells for $699. OEM discounts are available. The drive also comes in lower capacities. A similar unit with an IDE interface (the MiniPort 128A) is available as well.

The DockIt Socket is a PCMCIA docking slot that is compatible with any PC/AT computer. It lets users operate a PCMCIA drive as if it were a floppy disk, making it possible to interchange data between portables and desktops without any cables or linking software. The DockIt Socket sells for $249. RN

MiniStor Peripherals Corp., 2801 Orchard Pkwy., San Jose, CA 95134; (408) 943-0165. **CIRCLE 707**

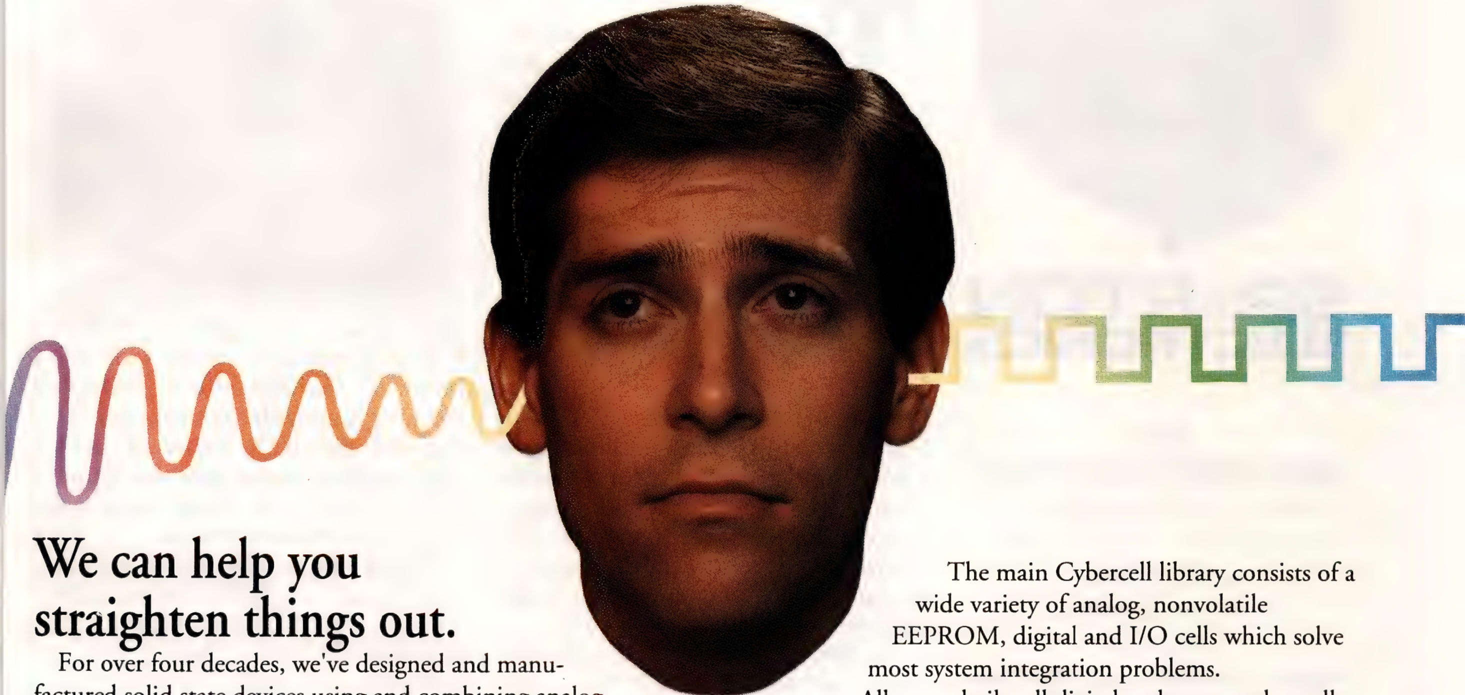
BOARD CAMERA SUITS VIDEO CONFERENCING

Video-teleconferencing becomes easier using the 1/3 CCD versatile board camera. The board camera is designed with a single-chip architecture that supplies equalized registration and white balance, advanced macro functionality, over 330 lines of horizontal resolution, and a signal-to-noise ratio above 46 dB. Other features include a 45° infinite field lens, a composite NTSC output, and an ac power adapter. The board camera can be integrated into an existing product or bundled with a digital video-capture board and application software. The 1/3 CCD comes in a stand-alone version or packaged in an enclosure. RN



Toshiba America Inc., 1010 Johnson Dr., Buffalo Grove, Ill 60089; (800) 253-3429, ext. 212. **CIRCLE 708**

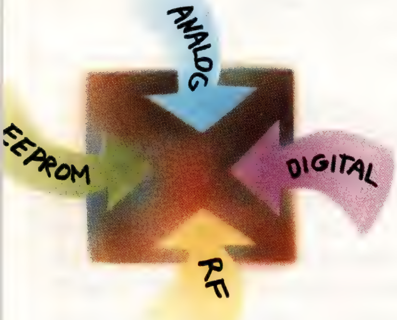
Been getting mixed signals on mixed signal ASICs?



We can help you straighten things out.

For over four decades, we've designed and manufactured solid state devices using and combining analog, digital and nonvolatile techniques. Today, using the Cybercell™ mixed signal library working in the Crescendo™ design environment, you can leverage our experience and more quickly bring break-though products to market.

Using and combining analog, digital, EEPROM and RF cells, you can create the IC which gives your new product the competitive edge.



The addition of EEPROM to a mixed signal ASIC allows storage of recognition codes, bootstrap procedures, power-down constraints and settings, multiplier coefficients, self-calibrating constraints or chip configuration information. Nonvolatile latches can be added to a digital counter allowing it to be reconfigured at any time or capable of storing the last count state before power shutdown. Nonvolatile latches may also be used to replace board components such as dip switches and jumper wires.

Analog solutions become simpler and less expensive when on-chip trimming techniques are used to enable circuit characteristics to be modified to suit a variety of applications.

The main Cybercell library consists of a wide variety of analog, nonvolatile EEPROM, digital and I/O cells which solve most system integration problems.

All nonvolatile, all digital and most analog cells operate from 3 to 10 volts over the full military temperature range. On a full custom basis, we are experienced in the design and production of mixed signal ICs which operate at 1.2 volts.

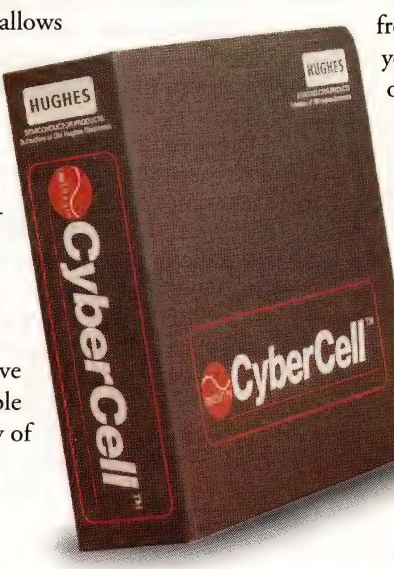
In addition to the core library, an RF specific library is the first of many niche application libraries which contain special macro cells to tackle specialized applications. Custom macros may be constructed for specific customer design requirements.

We want to make sure the IC you need is the IC you get.

That's why we hope to work with you from the very beginning as a member of your design team. You choose the level of teamwork you desire and we will assist you in any way.

For the straight facts on how you can leverage Hughes' experience in mixed signal ASICs using the CyberCell library, contact us today.

Hughes Microelectronics,
P.O. Box H, Newport Beach,
CA 92658-8903.
Phone (714)759-2934 or
FAX (714)759-2913.



HUGHES

HUGHES MICROELECTRONICS

...helping you create better products faster

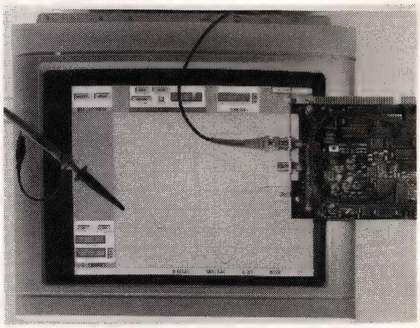
CIRCLE 116 FOR U.S. RESPONSE **CIRCLE 117 FOR RESPONSE OUTSIDE THE U.S.**

PC-BASED SCOPE CARDS OFFER 200-MHZ BANDWIDTH

The 420- and 430-series oscilloscope cards offer up to 200-MHz bandwidths in one- or two-channel models fitting into one 286-based PC expansion slot. The cards feature 27 timebase settings from 200 ms/div. to a minimum of only 5 ps/div. The sampling rate in single-shot mode is 12.5 MHz, and memory is 1024 samples/channel.

The scopes offer seven voltage ranges, ac and dc coupling, dc offset, and a probe compensation signal. An automatic trigger-level algorithm quickly establishes a valid trigger level. External ground planes shield the scopes from noise and create a safe path for static dissipation. The cards do not require adjustments or relays, which eliminates two major sources of reliability problems.

Included with each card is a BenchCom software package. This software provides the ability to view and print the waveform, translate the waveform data file to an ASCII list or spreadsheet format, and control the scope from DOS (using Basic, C, C++, or Pascal) and from Windows applications via a dynamic link library. BenchCom commands are based on the Standard Commands for Programmable Instruments. An optional BenchTop software package features a point-and-click graphical interface, so users need not know the command syntax.



Prices range from $1495 for the one-channel, 100-MHz bandwidth PCI-421 to $2695 for the two-channel, 200-MHz PCI-434. The BenchTop software costs $495. Delivery is in six weeks.

***PC Instruments Inc.**, 9261 Ravenna Rd., Bldg. B11, Twinsburg, OH 44087-2449; (216) 963-0800.* **CIRCLE 709**

■ *JOHN NOVELLINO*

SOFTWARE EASES WRITING OF FUNCTIONAL TESTS

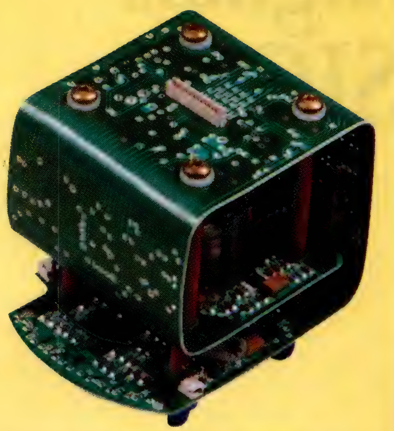
The Compass Test Environment is an open test development environment designed for use with the Geneva (GenRad Extended VXIbus-Based Architecture) test systems and for customer-built instrumentation systems. The tool package is aimed at production functional test applications. For fast start-up and ease of use, Compass is based on the Microsoft Windows environment. For instrument control, the package uses National Instruments' LabView graphical instrument-control software, which has a very large library of instrument drivers. The Compass Test Environment is available for immediate delivery for Geneva GR1000 and GR5000 platforms and for custom-built systems. JN

GenRad Inc., 300 Baker Ave., Concord, MA 01742-2174; (508) 369-4400. **CIRCLE 710**

DATA ACQUISITION CARD PLUGS INTO PCMCIA SLOT

The DAQCard-700 is a type II PCMCIA card that holds a 12-bit analog-to-digital converter and 16 single-ended or eight differential analog input channels. The card's power dissipation is low enough to make it suitable for use in battery-powered PCs. The unit features an 80-ksample/s sustained sampling rate, a 16-sample FIFO buffer, and multiple-channel scanning. Users can configure the input range for ±10, ±5, or ±2.5 V, with an analog signal resolution of 4.88 mV in the ±10-V range. The card has 16 TTL-compatible digital I/O lines and two user-available 16-bit counter-timer channels. All functions are software configurable. The DAQCard-700 costs $695.

National Instruments Corp., 6504 Bridge Point Pkwy., Austin, TX 78730-5039; (800) 433-3488 or (512) 794-0100. **CIRCLE 711**



SPARTON
ELECTRONICS

WILL
BEND OVER BACKWARDS
for you, and that's what you expect from a world leader in full service custom manufacturing.
We can
design, develop, manufacture and support your product,
with the most innovative, flexible and reliable practices available:
CAD
CONCURRENT ENGINEERING
DESIGN FOR MANUFACTURING
STATISTICAL PROCESS CONTROL
COMPLETE ELECTRONIC MANUFACTURING CAPABILITY
JUST-IN-TIME DELIVERY
Your Company Can
MINIMIZE
INVESTMENT IN INVENTORY,
FLOOR SPACE
AND EQUIPMENT COST
Thereby
INCREASING YOUR RETURN ON INVESTMENT

SPARTON
ELECTRONICS

WE MAKE WHAT YOU IMAGINE

5612 JOHNSON LAKE ROAD
P.O. BOX 788
DELEON SPRINGS, FL 32130

(904) 985-4631 FAX (904) 985-5036

CIRCLE 179 FOR U.S. RESPONSE
CIRCLE 180 FOR RESPONSE OUTSIDE THE U.S.

Spend 3 days at the PCB Design Conference.

Spend the year using what you've learned.

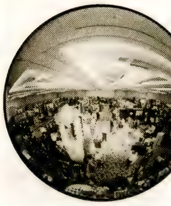
1994 Conference Highlights

➛40% more classes focusing on today's biggest challenges:

- *High Speed Design*
- *SMT*
- *Design For Manufacture*
- *Packaging (MCM, COB and more)*

➛Mix and match from dozens of lectures and workshops on topics like these:

- *The Rise and Fall of High Speed Design*
- *Advanced MCM Design Techniques*
- *Integrating DFM Into the Design Process*
- *Placement and Routing Strategies for Dense PCB's*
- *and many more*



➛More half-day tutorials

➛New optional full-day tutorials

➛A stellar lineup of the best lecture and workshop leaders including Jim Blankenhorn, Gary Ferrari, Richard Nedbal, Mary Sugden, Lee Ritchey, Tony Mazzullo and more...

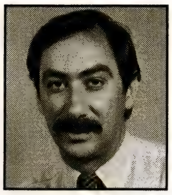
Comprehensive Product Exhibition

➛Meet face-to-face with all the major players in the PCB industry

➛Check out the hottest new products from the leading suppliers including Computervision, Protel, Harris EDA, Mentor Graphics, Altium, Racal-Redac and more...

Insightful Keynote Address

➛Tom Pennino, head of the Circuit Pack CAD Department in AT&T Design Automation Laboratories, will kick off PCB '94 with an insightful keynote entitled "Manufacturing Expectations of the Design Community"



Benchmark '94

➛Find out which software is best for your designs as you witness today's leading CAD software go head-to-head in an event which allows you to evaluate current EDA tools on a level playing field

Who Should Attend

➛You. The PCB Designer, ECAD Manager, Design Engineer or Engineering Manager interested in improving your PCB design skills and increasing your productivity

PCB
DESIGN CONFERENCE

March 29-31, 1994
At the Santa Clara Convention Center
Santa Clara, California

"Dedicated to the changing and expanding role of today's PCB Design Professional"

Tell Me More About PCB '94!

I am interested in:
☐ Attending ☐ Exhibiting

Sponsored by: PRINTED CIRCUIT DESIGN

NAME
TITLE MAIL STOP
COMPANY
ADDRESS
CITY STATE ZIP
PHONE FAX

Miller Freeman, Inc.
600 Harrison Street • San Francisco, CA 94107
415-905-2354 • FAX 415-905-2220

711

CIRCLE 142 FOR U.S. RESPONSE

CIRCLE 143 FOR RESPONSE OUTSIDE THE U.S.

Our Power Module is Dual...
theirs is only single output!

Patent Pending

- **Low Cost DC-DC Converters**
  Single Outputs $104 / Dual Outputs $149
- **Dual Isolated Outputs**
  28 Standard Models / Special Voltages Available
- **Wide Input Voltage**
  Four Series / 18-380 VDC Input
- **Parallel Operation**
  Fixed Frequency 100kHz
  True Redundancy Operation
- **100 Watts**

The availability of DUAL ISOLATED OUTPUTS creates cost and space savings in many applications.
Fully safeguarded for over voltage, over temperature and continuous short circuit protection, these FIXED Hi-Frequency units minimize technical problems.
With output voltages from 3.3 VDC to 100 VDC, four distinct input ranges and the choice of single or dual outputs plus the capability of Parallel Operation, as standard features, your circuit designs can be optimized.
Assembled in the U.S.A. with PICO quality components, these hi density units allow the most stringent mechanical, electrical and environmental requirements.

See EEM or send direct
for ***Free*** *PICO Catalog.*
Call toll free **800-431-1064**
in NY call **914-699-5514**
FAX **914-699-5565**

PICO Electronics, Inc.
453 N. MacQuesten Pkwy., Mt. Vernon, N.Y. 10552
CIRCLE 190 FOR U.S. RESPONSE
CIRCLE 191 FOR RESPONSE OUTSIDE THE U.S.

SYSTEM-LEVEL DEBUGGER LOOKS AT ASIC'S INTERNAL STATES

A system-level debugging solution, SystemTrace, allows engineers to observe an ASIC's internal behavior, monitoring the chip's response to various system stimuli and conditions. The product works with any ASIC that uses scan-based test techniques and ASIC gate arrays built with CrossCheck's proprietary test solution, ArrayTest.

The PC-based system accesses internal logic states through the device's test access port (TAP) and the company's TestLink TAP controller. Results are displayed on a Windows interface. SystemTrace exercises board control through CrossCheck's Universal Board Access Controller (UBAC). The product responds to software commands from the PC or to hardware commands from the trigger output of other debug equipment, like a microprocessor emulator or logic analyzer. As a result, the user can determine the ASIC's internal state after running at-speed to any microprocessor instruction or clock cycle, or after the board has attained a predetermined state.

Designers using ArrayTest can observe the ASIC's internal behavior without affecting its internal logic states. This allows the engineer to use single-stepping techniques to look at the internal states after a system-clock step or microprocessor-instruction step. Or designers can single-step a system until a specified internal logic state is reached.

The designer can read every test point in an embedded-test ASIC or any combination of test points. The netlist is presented in a hierarchical form, so the engineer can select test points at the gate level, functional level, or both. The Windows interface is also used to specify and display the desired internal logic states.

SystemTrace prices begin at $25,000 per license, with volume discounts available. The price includes the Test Link TAP controller and the UBAC schematic.

CrossCheck Technology Inc., *2833 Junction Ave., Suite 100, San Jose, CA 95134; (408) 432-9200.* **CIRCLE 712**

■ *JOHN NOVELLINO*

PC-BASED EMULATORS WORK WITH 8031/8051

The ET-iC8plus/Model 80 in-circuit emulator supports the 8031 and 8051 microprocessor families with real-time, no-wait-state emulation at speeds up to 42 MHz. The instrument's development environment includes a standard SAA user interface, a source-level debugger (SLD), a multifile editor, and an integrated project-management tool. The SLD screen displays either C source code, the corresponding assembly code, or both codes together, as well a watch points, which allow the designer to monitor critical variables. Prices for the ET-iC8plus/Model 80 start at $3175 for the 10-MHz version with 256 kbytes of overlay RAM. Delivery is within 10 days. JN

Emulation Technology Inc., 2344 Walsh Ave., Bldg. F, Santa Clara, CA 95051-1301; (408) 982-0660. **CIRCLE 713**

DESIGN-TO-TEST LINK GETS WAVES SUPPORT

The Waves Out-Converter module adds support for the IEEE-1029.1-1991 Waveform and Vector Exchange Specification (Waves) to the TDS (Test Development Series) suite of tools. The converter allows TDS users to exchange Waves-compatible simulation stimulus and response data with other users of VHDL simulation. TDS is vendor-independent software that automates the path for functional data from CAE to ATE. The software offers simulation analysis and rules checking, stimulus generation, testability auditing, tester resource checking, ATE test program generation, and test program conversion. The Waves Out-Converter is available now for $10,000. JN

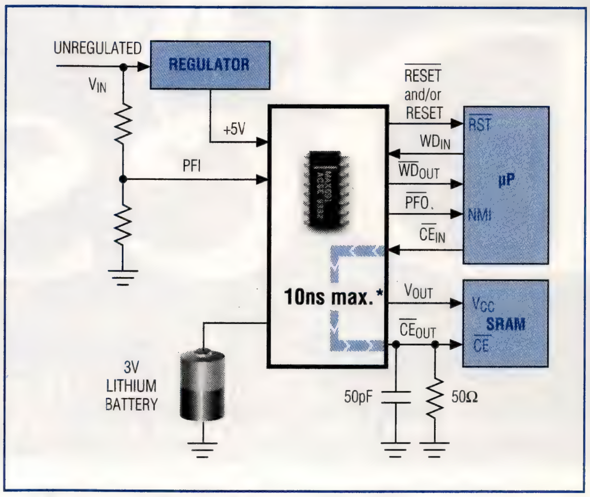
TSSI, 8205 S.W. Creekside Pl., Beaverton, OR 97005; (503) 643-9281. **CIRCLE 714**

MAX691A µP SUPERVISORS REDUCE POWER 50x†

Shortest $\overline{CE}$ Gate Delay: 10ns Max.*

Monitor battery voltage or other power line requiring low operating current and short $\overline{CE}$ gate delay, with the MAX691A and MAX693A. These newest additions to our extensive supervisor family offer the most functions with the highest accuracy.

- **Lowest Operating Supply current:**
  35µA (MAX691A/693A)
  200µA (MAX690A/692A)
- **Shortest $\overline{CE}$ Gate Delay:**
  6ns Typ., 10ns Max.*
- **Highest Output Current Drive:**
  250mA, 1.2Ω (MAX691A)
- **Lowest V_{BATT}-V_{OUT} On Resistance:**
  25Ω (MAX691A)
- **Most Accurate Power Fail:**
  ±2% over temp.
  (MAX800L/M, MAX802L/M)



The MAX691A provides complete µP supervision including RESET & $\overline{RESET}$, watchdog timing, chip-enable gating, power-fail warning, and battery-backup switchover.

Part	Reset Threshold (V)	Power-Fail Comparator	Battery-Backup Switch	Watchdog Timer	Active-High Reset	$\overline{CE}$ Protect	Batt-ON Output	Low-Line Output	I_{SUPPLY} (µA, Typ)
MAX691A	4.65	✓	25Ω	✓	✓	✓/10ns	✓	✓	35
MAX693A	4.40	✓	25Ω	✓	✓	✓/10ns	✓	✓	35
MAX690A	4.65	✓	400Ω	✓					200
MAX692A	4.40	✓	400Ω	✓					200
MAX800L	4.65	✓/±2% accuracy	25Ω	✓	✓	✓/10ns	✓	✓	35
MAX800M	4.40	✓/±2% accuracy	25Ω	✓	✓	✓/10ns	✓	✓	35
MAX802L	4.65	✓/±2% accuracy	400Ω	✓					200
MAX802M	4.40	✓/±2% accuracy	400Ω	✓					200

** Tested with 50Ω driver and 50pF load. Some competitors misrepresent this specification by not stating test conditions.*
†Compared with industry Standard MAX691.

µP SUPERVISORY ANALOG DESIGN GUIDE 5
First and Only +3V µP Supervisors with True Battery-Backup Switchover
Lowest-Cost µP Supervisor Has Power-On Reset
4th EDITION
MAXIM

FREE µP Supervisory Design Guide—*Sent Within 24 Hours!*
Includes: Data Sheets and Cards for Free Samples

CALL TOLL FREE 1-800-998-8800
For a Design Guide or Free Sample
MasterCard® and Visa® are accepted for Evaluation Kits or small quantity orders.

MAXIM

Maxim Integrated Products, 120 San Gabriel Drive, Sunnyvale, CA 94086, (408) 737-7600, FAX(408) 737-7194.

Distributed by Arrow, Bell, Digi-Key, Elmo, Hamilton Hallmark, and Nu Horizons. Authorized Maxim Representatives: **AL,** M-Squared, Inc.; **AZ,** Techni Source Inc.; **CA,** Mesa, Pro Associates, Inc., Centaur Corporation; **CO,** Component Sales; **CT,** Comp Rep Associates; **DE,** TAI Corporation; **FL,** Sales Engineering Concepts; **GA,** M-Squared, Inc.; **ID,** E.S. Chase; **IL,** Heartland Technical Marketing Inc.; **IN,** Technology Marketing Group; **IA,** JR Sales Engineering, Inc.; **KS,** Delltron; **LA,** BP Sales; **MD,** Micro-Comp, Inc.; **MA,** Comp Rep Associates; **MI,** Micro Tech Sales; **MN,** Mel Foster Technical Sales, Inc.; **MS,** M-Squared, Inc.; **MO,** Delltron; **MT,** E.S. Chase; **NE,** Delltron; **NV** (Reno, Tahoe area only) Pro Associates, Inc.; **NH,** Comp Rep Associates; **NJ,** Parallax, TAI Corporation; **NM,** Techni Source Inc.; **NY,** Parallax, Reagan/Compar; **NC,** M-Squared, Inc.; **OH,** Lyons Corporation; **OK,** BP Sales; **OR,** E.S. Chase; **PA** (Pittsburgh area) Lyons Corporation, (Philadelphia area) TAI Corporation; **SC,** M-Squared, Inc.; **TN,** M-Squared, Inc.; **TX,** BP Sales; **UT,** Luscombe Engineering Co.; **VA,** Micro-Comp, Inc.; **WA,** E.S. Chase; **WI,** Heartland Technical Marketing, Inc.
Distributed in Canada by Arrow. Authorized Maxim Representative in Canada: Tech Trek.

Maxim is a registered trademark of Maxim Integrated Products. © 1993 Maxim Integrated Products

CIRCLE 198 FOR U.S. RESPONSE
CIRCLE 199 FOR RESPONSE OUTSIDE THE U.S.

Portable by Design

A CONFERENCE FOR OEM DESIGNERS OF PORTABLE, HAND HELD, NOMADIC, MOBILE AND TRANSPORTABLE PRODUCTS.

PORTABLE DESIGN IS A SPECIAL DISCIPLINE

As a manager or designer of portable products your design criteria are as stringent as anything this side of a space probe.

You must design to tough standards in weight, size, EMI, ergonomics, power consumption, ruggedness, durability, connectivity, plus a myriad of other criteria.

WE'VE BEEN LISTENING TO YOUR NEEDS

The editors of **ELECTRONIC DESIGN** have organized a conference and series of workshops devoted to solving your design problems exclusively: **Portable by Design**.

HIGHLY EXPERIENCED TECHNICAL ADVISORY COMMITTEE

We have recruited 12 key design and project managers from successful manufacturers of portable products to identify the topics that need to be addressed in our conference and to set the standards for the technical papers to be presented.

70+ TECHNICAL PRESENTATIONS WILL COVER:

Microprocessors/Controllers
Operating Systems
Application Software
Power Circuits/Management
Batteries
Connectivity
Displays
Storage/Peripherals
Input Devices
Thermal Management
Ergonomics
PCMCIA

WORKSHOPS:
Accelerated Design,Ergonomics, EMI/RFI/ESD

Portable by Design

February 14-18
Santa Clara Convention Center
Santa Clara, CA
For a brochure use the
reader service number below
or call (201) 393-6075
FAX(201) 393-6073

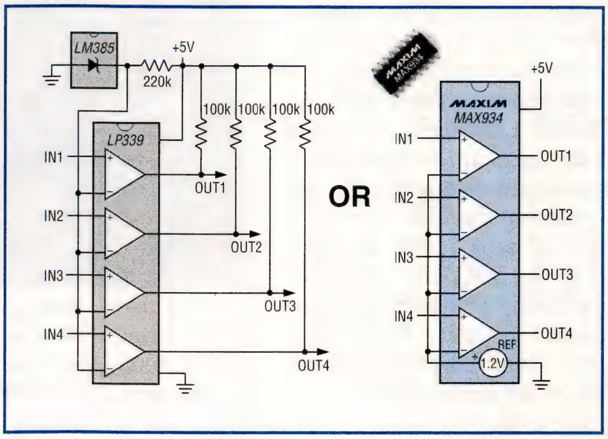
An **ELECTRONIC DESIGN** Production

CIRCLE 146 FOR U.S. RESPONSE
CIRCLE 147 FOR RESPONSE OUTSIDE THE U.S.

QUAD COMPARATOR & REFERENCE REPLACES 2 ICs AND CONSUMES 30-TIMES LESS POWER!

Low Voltage Comparators Plus 1.2V ±2% Reference Draw Less Than 6.5µA

- ◆ Single-Supply: 2.5V to 11V
  - * Input Range Includes GND
  - * Dual Supply: ±1.25V to ±5.5V
- ◆ Programmable Hysteresis
  - * No Effect on High-Z Inputs
  - * Independent of Supply Voltage
- ◆ TTL/CMOS Outputs Source 40mA
  - * No Pull-ups Required



MAX934 low-cost quad comparator + reference single IC solution: 30-times LESS power, less board space, easier to use!

Ideal for 3V and 5V battery-powered applications, the new MAX931, MAX932, MAX933, and MAX934 are the lowest power single, dual, and quad comparators available. These devices include a 1.2V ±2% reference, programmable hysteresis (MAX931/MAX932/MAX933), and TTL/CMOS outputs that source over 40mA and eliminate external pull-up resistors. The quad MAX934 replaces power-hungry, two-chip alternatives, such as the industry standard LP339 and LM385 reference, resulting in a greater than 30-times reduction in power.

Choose the Lowest Power Comparators for Battery-Powered Systems

DEVICE		TOTAL SUPPLY CURRENT (µA Max, 25°C)	INTERNAL REF ACCURACY OVER TEMP	PROGRAMMABLE HYSTERESIS	PACKAGE
MAX931	Single + Reference	3.2	±2%	YES	8-DIP/SO
MAX932	Dual + Reference	4.5	±2%	YES	8-DIP/SO
MAX933	Dual + Reference	4.5	±2%	YES	8-DIP/SO
MAX934	Quad + Reference	6.5	±2%	NO	16-DIP/SO

OP AMPS COMPARATORS ANALOG DESIGN GUIDE

Lowest Offset & Drift Micropower Dual/Quad Op Amps in SO Package

1.2µA Single/Dual/Quad Op Amps Swing Rail-to-Rail!

4th EDITION

MAXIM

FREE **Op Amp/Comparator Design Guide—*Sent Within 24 Hours!***
Includes: Data Sheets and Cards for Free Samples

CALL TOLL FREE 1-800-998-8800
For a Design Guide or Free Sample

MasterCard® and Visa® are accepted for Evaluation Kits or small quantity orders.

MAXIM

Maxim Integrated Products, 120 San Gabriel Drive, Sunnyvale, CA 94086, (408) 737-7600, FAX(408) 737-7194.

Distributed by Arrow, Bell, Digi-Key, Elmo, Hamilton Hallmark, and Nu Horizons. Authorized Maxim Representatives: **AL,** M-Squared, Inc.; **AZ,** Techni Source Inc.; **CA,** Mesa, Pro Associates, Inc., Centaur Corporation; **CO,** Component Sales; **CT,** Comp Rep Associates; **DE,** TAI Corporation; **FL,** Sales Engineering Concepts; **GA,** M-Squared, Inc.; **ID,** E.S. Chase; **IL,** Heartland Technical Marketing Inc.; **IN,** Technology Marketing Group; **IA,** JR Sales Engineering, Inc.; **KS,** Delltron; **LA,** BP Sales; **MD,** Micro-Comp, Inc.; **MA,** Comp Rep Associates; **MI,** Micro Tech Sales; **MN,** Mel Foster Technical Sales, Inc.; **MS,** M-Squared, Inc.; **MO,** Delltron; **MT,** E.S. Chase; **NE,** Delltron; **NV** (Reno, Tahoe area only) Pro Associates, Inc.; **NH,** Comp Rep Associates; **NJ,** Parallax, TAI Corporation; **NM,** Techni Source Inc.; **NY,** Parallax, Reagan/Compar; **NC,** M-Squared, Inc.; **OH,** Lyons Corporation; **OK,** BP Sales; **OR,** E.S. Chase; **PA** (Pittsburgh area) Lyons Corporation, (Philadelphia area) TAI Corporation; **SC,** M-Squared, Inc.; **TN,** M-Squared, Inc.; **TX,** BP Sales; **UT,** Luscombe Engineering Co.; **VA,** Micro-Comp, Inc.; **WA,** E.S. Chase; **WI,** Heartland Technical Marketing, Inc.
Distributed in Canada by Arrow. Authorized Maxim Representative in Canada: Tech Trek.

Maxim is a registered trademark of Maxim Integrated Products. © 1993 Maxim Integrated Products

CIRCLE 200 FOR U.S. RESPONSE CIRCLE 201 FOR RESPONSE OUTSIDE THE U.S.

FIBRE-CHANNEL CHIP SET TRIMS COSTS AND SIMPLIFIES SYSTEM DESIGNS

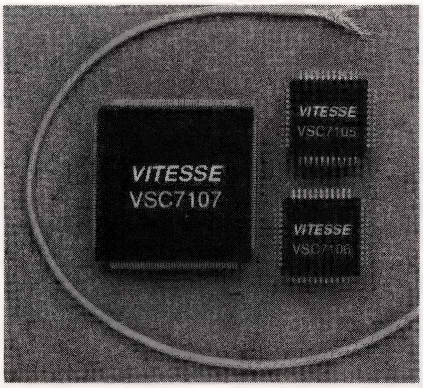
DAVE BURSKY

Transferring data at rates of 1.0625 Gbits/s, a three-chip set provides a Fibre-Channel compatible solution to meet the high-data-bandwidth needs of the current and upcoming computer applications. The EZ-Link chip set, developed jointly by Seagate Technology and Vitesse Semiconductor, consists of two gallium-arsenide circuits—the VSC7105 and 7106—and one CMOS chip, the VSC7107. Together, the trio of chips provides the main logic required to form a Fiber Channel adapter. Just a buffer memory and a few other low-complexity circuits complete the interface.

The VSC7105 performs the 1.0625 Gbit/s serial transmit function, while the VSC7106 handles the receive function, both according to the Fibre Channel protocol's FC-0 layer. Supporting both GaAs chips, the CMOS VSC7107 performs the lower-speed encoding and decoding for the 8B/10B protocol defined in the FC-1 layer of the Fibre Channel standard. The chip packs the multiplexing/demultiplexing function, link management, and cyclic-redundancy-check calculation/insertion.

The flexibility of the Fibre Channel standard allows Seagate to map the SCSI command set on the high-speed serial interface. Such a move reduces the cabling complexity and allows longer distances between SCSI devices. It also permits a six-fold throughput improvement over the 16-bit fast SCSI data rates of 20 Mbytes/s. Vitesse is also exploring additional partnerships to map higher-level protocols—such as the Peripheral-Component Interconnect (PCI) bus—to Fibre Channel.

The chip set is actually similar in function to Vitesse's previously released G-Taxi chip set, except that the EZ-Link chip set implements the Fibre-Channel protocols. Furthermore, the circuits were optimized for cost-sensitive systems through the partitioning of the logic into two GaAs chips and one CMOS chip.



The transmit and receive chips have a user-selectable 10- or 20-bit TTL-compatible parallel interface on the host side, and dual receiver serial inputs and transmitter outputs for loopback and multiple link applications. During transmission, parallel data is latched into the transmitter chip on the positive-going edge of the Transmit Clock signal for the 20-bit mode (or the rising edge of the Transmit Clock and the inverted Transmit Clock for the 10-bit mode). Once data is in the transmit chip, it's clocked into the serial-output shift register and then clocked out at 10 times the clock rate of the reference clock signal, thanks to the on-chip phase-locked loop clock multiplier.

On-chip clock-recovery circuits on the receive chip allow the circuit to extract the clock and data from the serial data stream. Once the clock is extracted, the data is retimed and then converted into either a 10- or 20-bit parallel output word. The VSC7106 also provides synchronization-character recognition and data-word alignment of the TTL-level-compatible output data bus. The transmitter and receiver chips can directly connect to either twin-ax coaxial cables or to fiber-optic drivers/receivers. With twin-ax cables the Fibre Channel nodes can be set up to about 30 meters apart; with fiber-optic cables, distances of 1 km or more can be supported. To give designers some flexibility and avoid a totally fixed solution, designers can partially disable portions of the CMOS chip or design their own support circuit to add unique functionality. The two GaAs chips operate from a 3.3-V power supply, support TTL I/O levels, and are housed in 44-lead plastic quad-sided flat packages.

The VSC7105/7106 transmitter/receiver chip duo sells for less than $90/set in 1000-set quantities. The CMOS VSC7107 will sell for less than $35 in similar quantities. Samples are immediately available.

Vitesse Semiconductor Corp., 741 Calle Plano, Camarillo, CA 93012; Howey Chin, (805) 388-3700.

CIRCLE 715

ROUTER SUPPORTS TCP/IP AND APPLETALK

The BitRUNR Turbo CS and XP are two of the first dial-up routers to simultaneously support TCP/IP, NetWare IPX, and AppleTalk protocols for network access and high-speed WAN connections. The new BitRUNR family provides remote and mobile uses with a single-vendor solution for network access. Designed for central site applications, the Turbo CS is expandable from 4 to 26 asynchronous ports, up to three T1/E1 synchronous ports, and up to six 128K bps WAN connections. Rack mountable in a 19-in. rack, it suits companies needing to support large numbers of remote offices and mobile users utilizing cellular, analog, or ISDN applications, and LAN-to-LAN routing applications that require dial-up or high-speed synchronous connectivity using leased lines or T1. It utilizes the industry defacto point-to-point protocol (PPP) standard, which allows it to be compatible with high-speed local backbone routers from other companies, including WelFleet, Cisco, and 3Com.

Both BitRURN products will be available in the fourth quarter of this year. Approximate pricing of a base unit begins at $2,495. Final cost depends on system requirements and configuration. A higher powered version of the Turbo CS, supporting larger configurations, is planned for release later this year. CM

Motorola UDS, 5000 Bradford Dr., Huntsville, AL 35805-1993; (205) 430-8000. **CIRCLE 716**

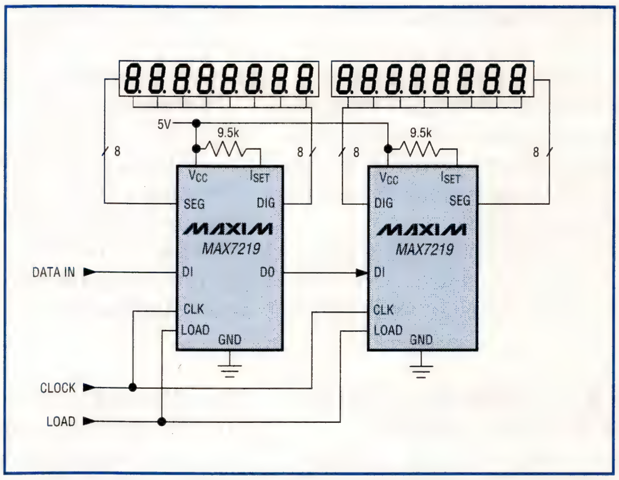
8-DIGIT 10MHz LED DISPLAY DRIVER WORKS WITH ANY µP!

New MAX7219 Has Easy-to-Use Serial 3-Wire Interface

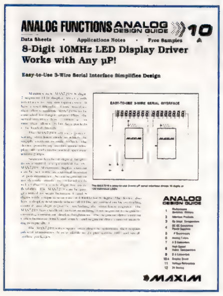
Designing 8-digit, 7-segment LED display drivers just became easier. The new MAX7219 has a 3-wire interface and 100ns access time that eliminates external latches and clumsy interfaces. And, the MAX7219's 24-pin SO package considerably reduces footprint size.

The MAX7219 provides 16 levels of digital brightness control with peak LED current set by an external resistor or potentiometer. Individual segment control is even easier, with 7-segment or no-decode digit selection for each of the 8 digits. You can drive eight 7-segment digits, 64 individual LEDs or any combination.

- **10MHz Serial µP Interface**
- **1kHz Scan Rate**
- **Brightness Control–Analog and Digital**
- **150µA Max Current in Shutdown Mode**
- **7-Segment or No-Decode Selectable for Each Digit**
- **24-Pin Narrow DIP or SO Packages**



The MAX7219's easy-to-use, 3-wire, µP serial interface drives 16 digits or 128 individual LEDs


ANALOG FUNCTIONS ANALOG DESIGN GUIDE 10

Data Sheets • Applications Notes • Free Samples

8-Digit 10MHz LED Display Driver Works with Any µP!

Easy-to-Use 3-Wire Serial Interface Simplifies Design

FREE Display Driver Design Guide–*Sent Within 24 Hours!* Includes: Data Sheets and Cards for Free Samples

CALL TOLL FREE 1-800-998-8800

For a Design Guide or Free Sample

MasterCard® and Visa® are accepted for Evaluation Kits or small quantity orders.

MAXIM

Accredited by the Dutch Council for Certification

ABS Quality Evaluations, Inc. ★ Quality Assurance Certification ★

REGISTRAR ACCREDITATION BOARD

ISO 9001

Certificate Number: 30337

Maxim Integrated Products, 120 San Gabriel Drive, Sunnyvale, CA 94086, (408) 737-7600, FAX(408) 737-7194.

Distributed by Arrow, Bell, Digi-Key, Elmo, Hamilton Hallmark, and Nu Horizons. Authorized Maxim Representatives: **AL,** M-Squared, Inc.; **AZ,** Techni Source Inc.; **CA,** Mesa, Pro Associates, Inc., Infinity Sales, Inc.; **CO,** Component Sales; **CT,** Comp Rep Associates; **DE,** TAI Corporation; **FL,** Sales Engineering Concepts; **GA,** M-Squared, Inc.; **ID,** E.S. Chase; **IL,** Heartland Technical Marketing Inc.; **IN,** Technology Marketing Group; **IA,** JR Sales Engineering, Inc.; **KS,** Delltron; **LA,** BP Sales; **MD,** Micro-Comp, Inc.; **MA,** Comp Rep Associates; **MI,** Micro Tech Sales; **MN,** Mel Foster Technical Sales, Inc.; **MS,** M-Squared, Inc.; **MO,** Delltron; **MT,** E.S. Chase; **NE,** Delltron; **NV** (Reno, Tahoe area only) Pro Associates, Inc.; **NH,** Comp Rep Associates; **NJ,** Parallax, TAI Corporation; **NM,** Techni Source Inc.; **NY,** Parallax, Reagan/Compar; **NC,** M-Squared, Inc.; **OH,** Lyons Corporation; **OK,** BP Sales; **OR,** E.S. Chase; **PA** (Pittsburgh area) Lyons Corporation, (Philadelphia area) TAI Corporation; **SC,** M-Squared, Inc.; **TN,** M-Squared, Inc.; **TX,** BP Sales; **UT,** Luscombe Engineering Co.; **VA,** Micro-Comp, Inc.; **WA,** E.S. Chase; **WI,** Heartland Technical Marketing, Inc.

Distributed in Canada by Arrow. Authorized Maxim Representative in Canada: Tech Trek.

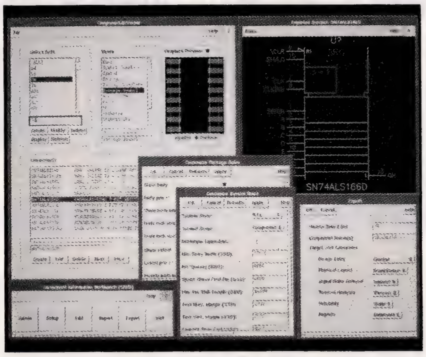
Maxim is a registered trademark of Maxim Integrated Products. © 1993 Maxim Integrated Products

CIRCLE 273 FOR U.S. RESPONSE **CIRCLE 274 FOR RESPONSE OUTSIDE THE U.S.**

TWO SOFTWARE TOOLS HELP ENGINEERING TEAMS DEVELOP AND MANAGE LIBRARIES AND DESIGN DATA

Two new tools from Cadence help engineering teams develop and manage libraries and design data. The first tool, called Component Information Workbench (CIWB), is a vendor-independent library development and management system targeted at system designers and EDA librarians. Teamwork Design Manager, the second of the two tools, is team-oriented software for managing, sharing, and releasing design data.

CIWB joins a unified data-entry environment, automatic library generation, and integrated management tools under one user interface. Using CWIB, engineering teams in heterogeneous EDA environments can integrate and manage component information from a variety of sources, including semiconductor companies, third-party reference-information suppliers, EDA-data vendors, and internal design groups.



A rules-based approach guarantees that all libraries are correct-by-design to meet industry and company-specific standards. More specifically, rules that control graphics generation, such as ANSI and JEDEC, are stored and managed separately from the parametric data that makes up the library characteristics. That way, company-specific rules can be entered to customize graphics to meet internal standards.

The second tool, Teamwork Design Manager, is aimed at managing the critical work-in-progress phase of design without affecting tool performance. One big advantage of the software is that it's open—not only will it manage files generated by Cadence applications, but it will manage design data from in-house or third-party tools as well. In addition, it's architected so that it can be used right away, without integration of encapsulation.

Teamwork Design Manager is equipped with built-in use models that help engineers working in multi-user teams to share and release data effectively. Users choose from four flexible models that provide varying degrees of formality and control of data-sharing procedures.

Component Information Workbench is delivered in a client-server fashion. The software is shipping now for Unix workstations. Prices start at $80,000, and vary according to size and configuration. Teamwork Design Manager also runs on Unix workstations. Pricing for a 20-user configuration starts at $4500 per seat. Cadence also offers consulting services to assist with both products.

Cadence Design Systems Inc., *555 River Oaks Pkwy., San Jose, CA 95134; (408) 943-1234.* **CIRCLE 717**

■ *LISA MALINIAK*

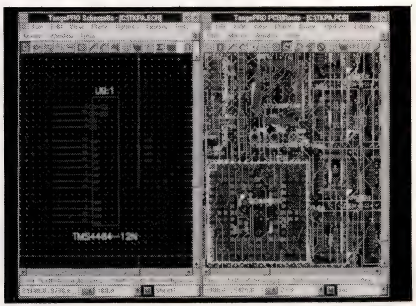
ACCELERATORS RUN FOUR TO SIX TIMES FASTER

Hardware and software enhancements added to Zycad's current XP simulation-accelerator family have yielded four to six times as much speed. The company claims that their new Paradigm XP family of accelerators can complete simulations up to 30 times faster than the current version of the Verilog-XL simulator running on an HP workstation. The XP hardware now includes larger, faster ASICs and high-speed memories in a super-scalar pipelined architecture. It can support from 256,000 to 16 million gates for logic simulation, and 64,000 to 4 million gates for fault simulation. Thanks to modular and incremental compilation, the software can deal with either monolithic designs, or large systems composed of individual modules. Users enjoy the support of a wide range of models, including those from Logic Modeling and assorted ASIC vendors. Also, Paradigm accelerators transparently interface with most of today's software-simulation environments, such as those from Cadence Design Systems, Mentor Graphics, Synopsys, and Viewlogic. The Paradigm XP accelerators are available now in three different configurations. Pricing starts at $57,500. LM

Zycad Corp., 47100 Bayside Pkwy., Fremont, CA 94538-9942; (800) 243-7286 or (510) 623-4400. **CIRCLE 718**

BOARD TOOLS COME IN LOW-COST VERSIONS

An enhanced version of the TangoPro for Windows pc-board tools and a Lite version of the tools are now available from Accel Technologies. The Lite versions are scaled back in capacity, but offer nearly all the functionality of the full versions for about one-fifth the price. TangoPro consists of a schematic-entry program, board-layout software, and a routing tool. Enhancements for Version 2.0 include forward and backward ECO support, hotlinked cross-probing between schematic and board layout, and integrated component libraries. TangoPro Schematic, TangoPro PCB, and TangoPro Route cost $1495, $5950, and $5500, respectively. Schematic Lite and PCB Lite go for $595 and $1995. All the tools run under Windows on the personal computer. LM



Accel Technologies Inc., 6825 Flanders Dr., San Diego, CA 92121-2986; (800) 488-0680. **CIRCLE 719**

CRITICAL-PARTS ANALYSIS PINPOINTS PERFORMANCE, RELIABILITY HOT SPOTS

Engineers can pinpoint the parts within a system that have the greatest impact on system performance and reliability with the Critical Part Identifier (CPI) software from Analogy. CPI has a set of analyses that transforms simulation data into useful performance and reliability information. It then identifies critical parts that most affect overall system operation.

The CPI software operates with the company's Saber simulator in the analog, digital, or mixed-technology (electrical, mechanical, hydraulic) domains. When CPI is enabled, it automatically changes the system parameters as necessary, runs the required simulations, reduces the results from waveforms to numbers, calculates the relationship between the results and the system parameters, and summarizes it all in a table.

CPI is powered by five basic elements. The first, a built-in measurement capability, lets users obtain a simple response from detailed data. Next, performance-sensitivity analysis uses that information to determine the sensitivity of a particular measurement to variations in any component. Also, dynamic-stress analysis evaluates that same information to find parts exceeding their safe operating areas. The last two elements are the access to Analogy's libraries and analog HDL, and a report generator.

Critical Part Identifier is sold as a $7000 option to the Saber simulator. Both tools run on Unix workstations.

***Analogy Inc.**, 9205 S. W. Gemini Dr., Beaverton, OR 97075; (503) 626-9700.* **CIRCLE 720**

■ *LISA MALINIAK*

IC-LAYOUT TOOL ADDS TECHNOLOGY SUPPORT

Tanner Research and MOSIS Service are offering updated ASIC-technology setup files for use with Tanner's full-custom IC-layout editor, L-Edit. MOSIS Service, Marina del Rey, Calif., offers fast-turnaround prototyping services for standard-cell and full-custom VLSI circuit development. These latest technology files support the MOSIS processes for Hewlett-Packard, Orbit Semiconductor, and VLSI Technology chip fabrication. Each setup file contains all technology layers and design-rule information for a specified process. L-Edit, which runs on a PC, is a hierarchical, graphical mask-layout editor that's used with other Tanner tools and the MOSIS Service for a low-cost ASIC design solution. Files for L-Edit are available from Tanner Research and from MOSIS. LM

Tanner Research Inc., 180 N. Vinedo Ave., Pasadena, CA 91107; (818) 792-3000. **CIRCLE 721**

When Your Power MOSFETS Must Be Protected Against Gate Voltage Spikes ...When Equipment Failure is Out of the Question...

ISO-GATE
MOSFET
DRIVERS
OPTICALLY ISOLATED—PHOTOVOLTAIC OUTPUT
PATENTED HIGH-SPEED TURNOFF

GUARANTEED*
AGAINST
GATE FAILURE
*The Laws of Physics guarantee that the series-connected photovoltaic diode array in our ISO-GATE MOSFET DRIVER absolutely CANNOT produce excessive output voltages, thus can NEVER damage the delicate MOSFET gate structure.

Never a Failure, ever!...in thousands of applications over 6 years!

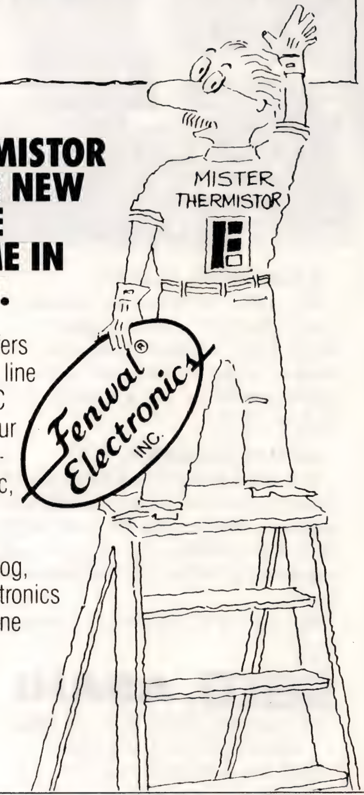
A Full Line of Standard, Off-the-Shelf, Single & Dual-Output Drivers to choose from, in low-cost plastic Mini-DIPs, Hermetic TO-5 and TO-18 Cans, & Hermetic 8-Pin Ceramic Side-Brazed DIPs.

Phone 516-997-7474 Fax 516-997-7479

DIONICS

65 RUSHMORE STREET, WESTBURY, L.I., N.Y. 11590

Interested readers are requested to contact DIONICS directly.



FENWAL ELECTRONICS
INCORPORATED

MISTER THERMISTOR PRESENTS THE NEW LOOK FOR THE LEADING NAME IN THERMISTORS.

Fenwal Electronics offers the industry a complete line of high-quality NTC/PTC thermistors. Including our Uni-Curve, Glass Encapsulated Chip, Bead, Disc, and PTC series.

For your copy of our Standard Products catalog, write or call Fenwal Electronics Incorporated, 450 Fortune Boulevard, Milford, MA 01757, (508) 478-6000.

CIRCLE 110 FOR U.S. RESPONSE
CIRCLE 111 FOR RESPONSE OUTSIDE THE U.S.

MPEG DECODER PACKAGE AIMS AT INTERACTIVE TELEVISION

All the software modules to design an MPEG decoder for interactive digital television are included in the DAVID (digital audio/video interactive decoder) package from Microware Systems Corp. The DAVID package is built around Microware's OS-9 or OS-9000 Real-Time Operating System. The Motion Picture File Manager (MPFM) controls the decompression and synchronization of MPEG-encoded digital audio and video. Also included are I/O managers that control wide area network (WAN) communications, graphic overlays, and infrared remote controls.

DAVID runs on either Motorola 68xxx or Intel 80x86 microprocessors and includes drivers for various MPEG audio/video decoders, graphics ICs, and communication interfaces. Modular in architecture, the software is ROMable or it can be downloaded over copper, fiber, or coaxial cable to a target subscriber's decoder.

DAVID's use of an innovative protocol enables set-top boxes to communicate with large-scale video servers operated by information service providers. Or the package's open architecture enables makers of set-top boxes to implement their own communication protocols.

Bundled with the OS-9 or OS-9000 real-time kernels are a graphics API title RAVE and six core I/O mangers: motion picture file manager; real-time network file manger; sequential character file manager; graphics file manager; a nonvolatile RAM file manager; and pipe file manager. A DAVID package, which includes the company's Ultra C compiler, source-level debugger, and a manufacturer's distribution license agreement, costs $75,000. A board package for developing a system decoder in a PC environment goes for $25,000.

Microware Systems Corp., 1900 N.W. 114th St., Des Moines, IA 50325-7077; (800) 475-9000 or (515) 224-1929; fax -1352. **CIRCLE 722**

■ *SHERRIE VAN TYLE*

EVERYTHING IN DPMS
DC and AC voltmeters and ammeters, process monitors, setpoint comparators, thermometers, counters, tachometers, frequency meters, strain gauge meters, remote monitors — even a versatile, modular DPM.

ADVANCED DESIGN, TOO
Our FREE Digital Instrument Selection Guide pinpoints hundreds of models and variations. With features like large, bright digits, high resolution, fast response, and exceptional reliability. OEM discounts, of course.

Just think of us as DPM CITY. Because we are.

selco/ASAHI
7580 Stage Rd., Buena Park, CA 90621
(310) 921-0681, (714) 521-8673
(800) 229-2332, FAX (714) 739-1507

CIRCLE 152 FOR U.S. RESPONSE
CIRCLE 153 FOR RESPONSE OUTSIDE THE U.S.

TOOLKITS TARGET X EMBEDDED TASKS

An evaluation kit for the XoftWare Advanced Technology Software (ATX) X Window software system includes a multitasking executive, XoftWare X11R5 server, and Xlibraries, local clients, XoftNet communication software, XoftBoot ROM-based boot software, configuration software, and utilities. The kits run on LSI LR33020 RacerX Development Hardware. XoftWare ATX is available for MIPS-based microprocessors, Intel i960, AMD29K, TI34020 series, and Motorola 88K microprocessors. With ATX, an embedded application developer or X terminal manufacturer can build an MIT X11R5-based system that can be optimized for the selected microprocessor and specific display hardware. Included are the basic protocols ARP, IP, UDP, TCP, ICMP, and SL/IP. Call for prices. SVT

AGE Logic Inc., 9985 Pacific Heights Blvd., San Diego, CA 92121; (619) 455-8600; fax 597-6030. **CIRCLE 723**

MANAGEMENT PROGRAM SUPPORTS NETWARE

The HTI:Origen Version 3.0 network management automation software program enables LAN managers to cut, paste, modify, and selectively combine NetWare 2.x, 3.x, and 4.x server templates throughout an enterprise. According to the tool's maker, it is the only network management tool that enables NetWare 2.x, 3.x, and 4.x file server configurations to be captured, changed offline, merged together, or separated and automatically reconfigured. An option enables LAN managers to standardize and structure selective parts of networks to be transferred or reconfigured. Pricing for HTI: Origen begins at $545 for a single server base license. An additional server license is $435. SVT

Horizons Technology Inc., 3990 Ruffin Rd., San Diego, CA 92123-1826; (619) 292-8331; fax -7321. **CIRCLE 724**

TOOL ANALYZES C CODE IN 3D

Ensemble Viewer is an interactive two- and three-dimensional graphical tool for visualizing C programs. Viewer affords browsing of program flow, data structure, and physical file structure. The tool supplies interactive views of key program aspects by displaying program information and test results stored in the Ensemble database. A user can understand the program and see the result of program changes without having to read through the detailed source code. Part of the company's Ensemble suite of C development tools, Viewer runs on Sun Sparcstations now and will be available on HP9000 and IBM RS/6000 workstations in February. Prices start at $2400. SVT

Cadre Technologies Inc., 222 Richmond St., Providence, RI 02903; (401)351-5950;fax-7380. **CIRCLE 725**

SLIDE-SWITCH BOOK COVERS WIDE VARIETY

Over 200 slide-switch model numbers are completely described with all specifications, drawings, and photos in the No. SL0893 catalog from MORS/ASC, Wakefield, Mass. Convenient "build your own switch" formats enable numerous additional switches to be specified as well. The 60-page catalog's contents section contains an easy-to-use selection guide as well as key parameters and page numbers. DM **CIRCLE 940**

BROCHURE SHOWCASES SEALED CONNECTORS

A small, low-cost, environmentally sealed connector with high-density contact configurations is the subject of a four-page brochure from Deutsch Commercial Products Div., Banning, Calif. The MMP Series connectors' shell sizes range from 0.600 in. to 0.938 in. with seven available insert arrangements. The brochure offers a complete description with dimensional diagrams and drawings of the various insert arrangements. Tables detail contact part numbers, dimensions, and tooling. DM **CIRCLE 941**

CRYSTAL SELECTOR OFFERS GUIDANCE

How to select the best clock crystal for a given application is the tack taken by an in-depth crystal and oscillator selection guide from MF Electronics Corp., New Rochelle, N.Y. Special emphasis is placed on choosing custom crystals for more unusual design applications involving special conditions and case sizes. All pertinent selection criteria are listed and defined, including frequency range, overtone and case size (and how they relate), load, resistance, drive level, operating-temperature range, calibration, stability, and more. Diagrams show the dimensions of various crystal holders. DM **CIRCLE 942**

POSTERS RAISE STATIC AWARENESS

Six wall posters from 3M Electrical Specialties Div., Austin, Texas, are designed to increase static awareness among personnel in facilities with static-control programs. The posters remind personnel to use various static procedures and control products, including test and measurement equipment, static bags, wrist straps, ionizers, and containers. The 16-by-20-in. posters are also available in Spanish-language versions. DM **CIRCLE 943**

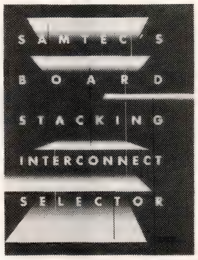
HANDBOOK COVERS INSTRUMENTATION

A 106-page design guide and catalog from Calex Mfg. Co. Inc., Concord, Calif., covers a wide range of instrumentation including modular load cell and strain-gage signal conditioners, dc-isolated transmitters, constant-current sources, alarms, and op amps. It also covers dc-dc converters and linear supplies for powering instrumentation modules. Complete detailed specs, circuit diagrams, and descriptions are included, as are a selection guide and block diagrams. Tutorials are presented on op-amp applications, constant-current theory and applications, instrumentation amplifiers, and grounding and shielding techniques. DM **CIRCLE 944**

RECTIFIERS AND ZENERS COVERED IN CATALOG

Rectifiers, Zener diodes, and transient-suppression devices are detailed in a 20-page catalog from Sussex Semiconductor Inc., Branchville, N.J. Rectifier diodes offer peak reverse voltages of up to 1200 V, handle currents of up to 100 A, and have 35-ns recovery times. Zeners are available with capacities to 50 W, and transient-suppression devices offer ratings of up to 60 kW. Products are available packaged as SMT devices, in die form, and as flip dice. The catalog includes complete specifications for all devices. DM **CIRCLE 945**

SELECT CONNECTORS FOR BOARD STACKING



The fourth edition of the Board Stacking Interconnect Selector from Samtec Inc., New Albany, Ind., makes it easy to find the right interconnection for board-stacking applications. Thousands of interconnect types and combinations are shown, including 1-mm and 0.050-in. micro-pitch and surface-mount connectors. Products are arranged by through-hole and SMT types, and are further categorized by lead pitch. Quick reference drawings are provided for most applications. DM **CIRCLE 946**

80C51 HANDBOOK DETAILS APPS

Over 50 application notes covering a broad range of 80C51-based 8-bit microcontrollers are contained in a 629-page handbook from Philips Semiconductors, Sunnyvale, Calif. Detailed descriptions are included for such applications as controlling air-core meters, airflow measurement, power management for notebook computers, a fast NiCd charger, an ACCESS.BUS mouse, desktop connectivity, and low RF-emission applications. DM **CIRCLE 947**

IC-SOCKET GUIDE OFFERS LARGE SELECTION

A large, full-line catalog of IC sockets showcases one of the industry's widest offerings of device interconnections. The catalog, from McKenzie Technology, Fremont, Calif., includes lines of DIP and SIP sockets, adapters, and headers; ZIP sockets and adaptors; press-fit sockets; PGA sockets, adapters, and headers; high-density interconnections; PLCC, LCC, and QFP sockets and adaptors; board-to-board interconnects; and more. Complete technical information is included with all dimensions and pin-pattern diagrams. The catalog is well indexed and also offers a list of engineering abbreviations and acronyms. DM **CIRCLE 948**

Test engineering isn't just our last step. . .

...it's a part of every step, for every design we create. At Quantum, Test Engineers are an integral part of the product development process, ensuring that our storage systems are designed right the first time. In fact, over half of our Test Engineers started out as Design Engineers in the industry. Test Engineering here is a multifaceted challenge, vital to our continued product leadership. Consider building your engineering acumen into some of the world's most dependable mass storage devices.

TEST ENGINEERING PROFESSIONALS

Seasoned Test Engineering professionals sought with seven plus years' experience, preferably with mass storage systems. BS required (MS preferred). Work with our Test Process Development team to design hardware, software, and production tests for our next generation mass storage systems. Qualified candidates will have expertise in most or all of these areas:

- C, C++, Object-oriented programming
- Assembly language programming
- Analog circuit design
- Digital circuit design
- Servo control systems
- Frequency domain measurement techniques

We also have openings for Design Engineers (Read/Write) and Commodity Engineers.

Quantum is a dynamic, creative environment dedicated to developing superior, leading-edge products for the fast-growing, fast-changing mass storage marketplace. For consideration, please send or fax your resume to: Quantum, Human Resources Dept., Job Code ADED110A, 500 McCarthy Blvd., Milpitas, CA 95035, FAX (408) 894-4152. Equal opportunity employer M/F/D/V.

Quantum

Drive For Excellence

EMPLOYMENT OPPORTUNITIES

Integrated Circuit Modeling Engineer - Research and development of advanced models for integrated circuit packages, interconnects, and test equipment through electro-magnetic simulation and measurements to provide accurate statistical circuit simulation correlation. Duties include research and development of statistical analysis techniques, enhanced methods to characterize integrated circuit packages, interconnects, and test equipment, and efficient models to improve circuit simulation correlation; develop and improve measurement techniques for LCR meter, Network Analyzer, TDR, and model parameter extraction methodologies. Requirements include Master of Science degree in Electrical Engineering; thorough knowledge of electrical characterization of integrated circuit packages, interconnects, and test equipment, microwave probing theory and techniques, scattering parameter measurement theory, techniques, and data extraction, and de-embedding theory and application in interconnect characterization of MOS and Bipolar circuits; circuit simulation tools such as Spice, Hspice, and Touchstone microwave circuit simulator, and interconnect/package analysis program; strong background in high frequency probing with microwave probes; HPBASIC programming language and HP instrumentation, Electro-Magnetic field and microwave circuits theory. No experience required. Salary $37,680. - $47,000./year. 40 hours/wk. Respond with two copies of resume to Job Order #2990677, Labor Certification Unit, Maine Department of Labor, 20 Union Street, Augusta, Maine 04330.

DESIGN/DEVEL. ENGRS./MGRS.
$30,000-$70,000+

30+ yrs. in placing Electrical/Electronic Engrs. Nationwide client list and 200 associate office resources. All fees Co. paid. Contact Gordon Hassell with resume/salary/location data. G.E. HASSELL ASSOCIATES, 913 MAIN PLACE, P.O. BOX 471, NILES, OH 44446. (216) 652-5871

SURPLUS INVENTORY

SURPLUS SALE

200,000 WALL TRANSFORMERS

7.5 VDC	50 MA	0.85
12 VDC	100 MA	1.10
12 VDC	500 MA	1.75
12 VDC	800 MA	2.10
14 VAC	500 MA	1.75
16 VAC	1.25 A	2.95

Min 1000/type - - Call for other types

SURPLUS TRADERS
PO Box 276,
Alburg, Vt. 05440
Tel: 514-739-9328
Fax: 514-345-8303

FREE CATALOG!

FAX YOUR ORDER!

To Advertise in Penton Classifieds

FAX:
(216) 696-8207

DEBUGGER RUNS ON SPECTRA BACKPLANE

The XRAY source-level debugger is available for Spectra, Ready System's open cross-development backplane. XRAY for Spectra forms a bridge between the suite of host-based tools in the MasterWorks integrated C and C++ development environment and the Spectra tools and backplane. The tool supplies source-level debugging of optimized C and C++ code. XRAY plugs directly into Spectra's ToolBuilder interface, giving access to the VRTXsa and VRTX32 real-time kernels. Through Spectra, XRAY can obtain information about the state of tasks and other system resources. The developer also benefits from more control over the debugging session, such as the ability to set breakpoints on a per-task basis. XRAY for Spectra runs on Sparcstations and applications that use Motorola's 68000 family of processors, with more hosts and targets planned. Pricing starts at $4320. SVT

Microtec Research Inc., 2350 Mission College Blvd., Santa Clara, CA 95054; (800) 950-5554 or (408) 980-1300; fax 982-8266. **CIRCLE 726**

TOOLS DEVELOP EMBEDDED DSP APPS

The SwiftTools integrated software development environment for real-time, embedded DSP applications works with the company's family of digital-signal-processing products incorporating Texas Instruments' TMS320C30 and '40 DSP chips. Version 2.0 includes interactive, multitasking development and debugging of the C language on PC or Sun platforms. Besides having any number of sessions open at the same time, a developer can have any number of separate sessions defined for each target in an integrated cross-development environment. Upgrades from previous versions are free of charge. List price for SwiftTools DOS Version 2.0 is $1000; $2000 on Sun. SVT

Pentek Inc., 55 Walnut St., Norwood, NJ 07648; (201) 767-7100; fax -3994. **CIRCLE 727**

SYSTEM DESIGN TOOLS ARE ENHANCED

Engineers designing systems may find useful enhancements in the latest version of the Statemate system design automation (SDA) tools, including support for requirements traceability, support for chart-level instantiation, which is a first step toward support for object-oriented analysis, and an interface to Cadre Technology's Teamwork CASE environment. Statemate 5.0 users can create generic charts that supply multiple copies of a particular Statechart or activity chart, reducing the time spent creating complex models. The toolset's graphical models supply the design engineer with a mathematically rigorous model of system specifications and requirements. It also supplies vigorous automated tracking requirements and reduces the need for traditional tedious and time-consuming manual method of requirements tracking. The company also developed a bidirectional interface to Cadre's Teamwork CASE environment, enabling engineers to pass such information as data-flow diagrams and state transition diagrams, decision tables, process activation tables, data dictionaries, and information flow between Statemate and Cadre's Teamwork. Contact the company for pricing. SVT

i-Logix, 22 Third Ave., Burlington, MA 01803; (617) 272-8090; fax -8035. **CIRCLE 728**

CONFIGURATION SOFTWARE DEBUTS

Object CM, an object-oriented configuration management system, improves management of software development processes and can boost programmer productivity. Object CM integrates an object base that is compliant with the Portable Tools Environment (PCTE), an emerging standard for integration of CASE tools. Object CM supplies an advanced configuration management system, including a PCTE-based object-oriented repository, graphical user interface, object browser, system administration facility, and productivity tools. Integral to the system is a change control facility, which allows for the creation and tracking of trouble reports and change requests and their association with the software objects. Introductory price for a five-user license for Object CM is $9,995. SVT

Alsys, 10251 Vista Sorrento Pkwy., Suite 300, San Diego, CA 92121-2706; (619) 457-2700; fax 452-2117; CASE division fax: (619) 452-1334. **CIRCLE 729**

Sipex

SIGNAL PROCESSING EXCELLENCE

Our "SP574B" Family Samples a Full Spread at the Table...

12 Bit ADC	SP574B	SP674B	SP1674B	SP774B
Conv.Time	25µSec	15µSec	10µSec	8µSec
Nyquist F(in)	20kHz	33kHz	50kHz	62kHz
SINAD	72dB	72dB	71dB	71dB
Price*	**$8.00**	**$9.00**	**$10.00**	**$12.00**

* @ 1k Qty - K version (±0.5 LSB, 0° to 70°C) in PDIP, PLCC or SOIC

The Sipex SP574B family members are 12-Bit Monolithic Analog-to-Digital Converters that offer true "Nyquist" Sampling for critical AC applications as well as for standard implementation...

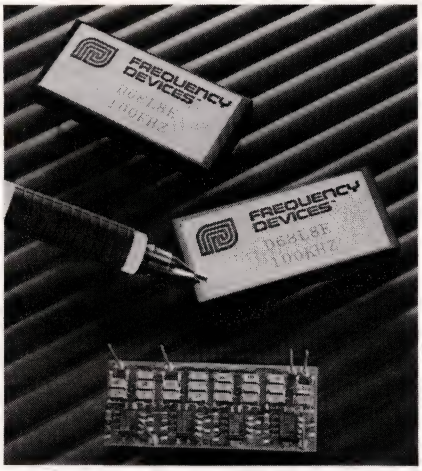
...available in all Temperature Ranges

Sipex

SIPEX Corporation • 22 Linnell Circle • Billerica MA 01821 • Tel: 508-667-8700 • Fax: 508-670-9001

CIRCLE 156 FOR U.S. RESPONSE CIRCLE 157 FOR RESPONSE OUTSIDE THE U.S.

LINEAR ACTIVE FILTERS KEEP DISTORTION LOW



To complement its existing D70 line of DIP fixed-frequency, linear active filters, Frequency Devices is offering its D68 series of filters. The devices offer a broader frequency range, a wider choice of transfer functions, and tighter tolerances in a somewhat larger package.

Like their smaller siblings, the D68 filters comprise a self-contained solution that requires no external components, clock signals, or additional filtering. With both low- and high-pass options available, bandpass and notch filters can be constructed using a minimum of board real estate. The D68 devices retain the D70 units' 0.3-in. height to accommodate board stacking.

For applications in which filtered-signal shape is more important than the steepness of the attenuation curve, the D68 line's Bessel and Butterworth models offer harmonic distortion below –100 dB and a theoretically unlimited attenuation floor. Constant-delay filters furnish more linear phase response than Butterworth types and faster attenuation than Bessel filters, with an attenuation floor of better than –80 dB. Typical ±1° unit-to-unit phase matchint permits precise signal comparisons from several filter channels.

In single quantities, the D68 filters cost $145, with prices dropping to $115 in lots of 1000. Delivery is in from three to four weeks.

***Frequency Devices Inc.**, 25 Locust St., Haverhill, MA 01832; Gregory Anderson, (508) 374-0761.* **CIRCLE 730**

■ *DAVID MALINIAK*

ACCELEROMETER OFFERS LOW-NOISE OPERATION

A line of machine-monitoring accelerometers, featuring piezo-film sensor technology, provide low-noise operation and high sensitivity in a rugged stainless-steel or titanium package. The units' low noise floor, high 120-dB dynamic range, and high sensitivity of 100 mV to 10 V per g allow detection of a wide range of signals with very low acceleration levels. The rugged housing and the piezo film's low Q facilitate high-frequency capabilities, as does a frequency response of up to 20 to 30 kHz. Pricing ranges from $100 to $1000 each, depending on quantity and configuration. DM

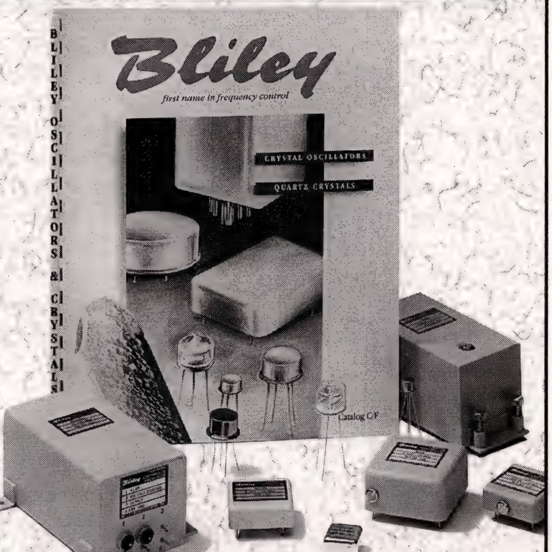
AMP Sensors Inc., P.O. Box 3608, Harrisburg, PA 17105-3608; (215) 666-3500. **CIRCLE 731**

YIG-TUNED OSCILLATOR TUNES FROM 20 TO 40 GHZ

The AV-20040 yttrium iron garnet-(YIG-) tuned oscillator is believed to be the first oscillator of its type to tune from 20 to 40 GHz. The unit is a fundamental-output signal source that uses no frequency multiplication. Because it is a single-band, fundamental-output design, the AV-20040 eliminates expensive millimeter-wave multipliers, filters, and switching circuitry. It also means a very low spurious output of a minimum –60 dBc. Other features include a 10-mW output and low frequency drift of 60 MHz maximum. The unit operates from a single +15-V dc source. Pricing in lots of one to nine is $3675. DM

Hewlett-Packard Co., P.O. Box 58059, 5301 Stevens Creek Blvd., Santa Clara, CA 95052-8059; (800) 537-7715, ext. 7938. **CIRCLE 732**

NEW 1994 CATALOG!


BLILEY OSCILLATORS & CRYSTALS
Bliley
first name in frequency control
CRYSTAL OSCILLATORS
QUARTZ CRYSTALS
Catalog CF

We "Wrote the Book" on
Hi-Rel Oscillators and Crystals.
You Can Have A Copy, Free.

MADE IN USA
BLILEY ELECTRIC COMPANY

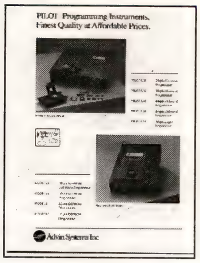
Bliley
2545 West Grandview Blvd.
P.O. Box 3428, Erie, PA 16508
(814) 838-3571 • Fax: (814) 833-2712

CIRCLE 94 FOR U.S. RESPONSE
CIRCLE 95 FOR RESPONSE OUTSIDE THE U.S.

CATALOG/LITERATURE REVIEW

Device programmers

Affordable, dependable & versatile, ADVIN offers a full line of device programmers. All pkg types supported. IC mfgs approved. Free lifetime s/w updates via electronic bbs. Call for free catalog & latest supported devices list.


PILOT Programming Instruments. Finest Quality at Affordable Prices.
Advin Systems Inc

CIRCLE 287

ADVIN SYSTEMS INC.

Short form designers guide

Free comprehensive guide to the entire ANALOG DEVICES, INC. product line. Includes component selection trees and critical specifications to identify best choices.

CIRCLE 288

ANALOG DEVICES, INC.

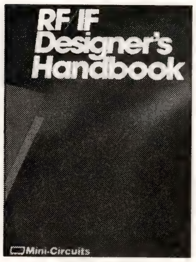
Bliley offers 1994 catalog

Crystal oscillators & quartz crystals are reviewed in a reader friendly format. Spec tables, performance features cover ocxo, tcxo, vcxo, tcvcxo & clocks. Bliley quartz crystals and blanks also detailed. RFQ forms are included.

CIRCLE 289

BLILEY ELECTRIC CO.

Now... the most informative and comprehensiv reference manual for RF/IF signal-processing components! Mini-Circuits new 740-pg Handbook is loaded with practical articles, answers to most-frequently asked questions definitions of terms convenient selection guides, and handy conversion charts.

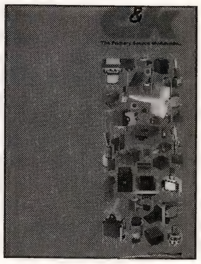


CIRCLE 290

MINI-CIRCUITS

NEW C&K NEWTON DIVISION CATALOG

C&K has just released the most extensive switch catalog in the industry, the NEWTON Division Switch Catalog #9308, with more than 325 pages. It has hundreds of new switches, models and options featuring miniature, subminiature and ultra-miniature toggles, and compatible switches.

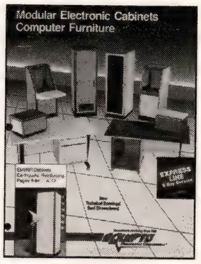


CIRCLE 291

C&K COMPONENTS

Much New In Free Enclosures Catalog

More EMI/RFI shielded cabinets are offered. Shielding effectiveness test data have been revised. Earthquake reinforced enclosures have been added. New, too are dual dimensioned technical drawings in this over 300-page free catalog on modular cabinets, and computer furniture

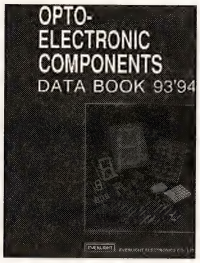


CIRCLE 292

EQUIPTO ELECTRONICS

Optoelectronic Data Book

Contains technical data on low current, multi-color and extra bright lamps, infrared LEDs, phototransistors, digit and dot matrix displays, clock displays, SMD lamps, CdS cells and photo interruptors carried by Sodus, NY firm.



CIRCLE 293

EVERLIGHT ELECTRONICS CO.

Hamamatsu Technical Brief

Details Xenon Flash Lamps Hamamatsu's Xenon Flash Lamps technical guide provides a comprehensive look at the details of these devices. The 20 page technical guide covers basic information, construction, operation, and power supply requirements for xenon flash lamps, with technical data.

CIRCLE 294

HAMAMATSU CORP.

DIN CONNECTORS

Colorful brochure provides detailed information and specifications on HARTING's Gds A standard DIN 41612 printed circuit board connectors. ISO 9001 certified. Mounted & fixed to the PC board in single procedure. Wide range with many styles of shell housings.

CIRCLE295

HARTING ELECTRONIK, INC.

KEPCO DC POWER SUPPLIES

Kepco's new full-line catalog covers: heavy duty industrial grade switches, a-c to d-c and d-c to d-c, including hot swappable plug-ins; bench type power supplies, digital meters and much more. Includes handbook of principles and applications. Dept. Mzs-05, KEPCO, Inc. Flushing, N.Y. 11352. 718-461-7000. Fax: 718-767-1102.

CIRCLE 296

KEPCO, INC.

Component Catalog

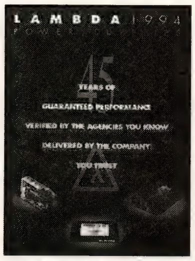
Keystone's full line 96-page catalog features a full range of Battery Hardware, PCB Hardware, Interconnect Components, Panel and Computer Hardware and Insulation Hardware. This catalog contains detailed drawings, specifications, and application data.

CIRCLE 297

Keystone Electronics Corp.

POWER SUPPLIES

A new 168 page full line catalog is available on request from Lambda Electronics Inc., N.Y.. It contains detailed information and prices on over 1000 standard power supplies, systems and accessories including 200 new products.


LAMBDA 1994
45 YEARS OF GUARANTEED PERFORMANCE
VERIFIED BY THE AGENCIES YOU KNOW
DELIVERED BY THE COMPANY YOU TRUST

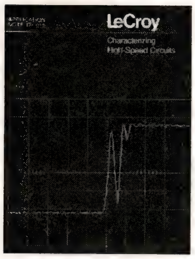
CIRCLE 298

LAMBDA ELECTRONICS INC.

TROUBLESHOOTING CIRCUITS

High-speed circuits are the focus of LeCroy's new Application Note. It discusses the uses of digital oscilloscopes to troubleshoot crosstalk, PC BUS Terminaions, grounding and other problems in circuits to 1 GHz.

1-800-4-Lecroy.

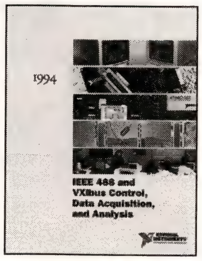


CIRCLE 299

LeCROY CORPORATION

Computer-Based Instrumentation

Free 1994 catalog of hardware and software for computer-based instrumentation. Features instrumentation software for Windows, Windows NT, Macintosh, UNIX, and Dos, includes LabVIEW, LabWindows, and the new LabWindows/CVI. Describes IEEE 488.2 interfaces..

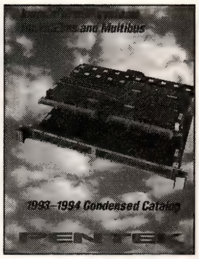


CIRCLE 300

National Instruments

DSP Systems Catalog

New catalog describes products for VMEbus and Multibus. Included are DSP processors, data acquistion boards, T1/PCM-30 transceivers, software development tools, and much more. Send, call or fax for your free copy today.



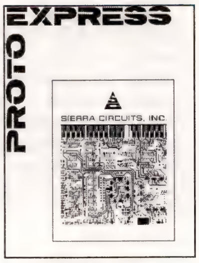
CIRCLE 301

PENTEK,INC.

CATALOG/LITERATURE REVIEW

PROTO EXPRESS

Multilayer prototypes in 1 to 5 days. FR4 and polyimide. Commerical or Milspec capabilities * buried / blind VIRS * carbon paste * up to 22 layers call Ken or Joycie 408-735-7137 phone 408-735-1408 - Fax

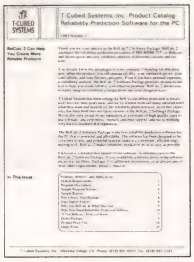


CIRCLE 361

Proto Express

Reliability Prediction

Catalog describes the RelCalc2 software Package, which automates Mil-HDBK-217 or Bellcore on your PC, and allows quick and easy reliability analysis of your electronic products. Phone: (818) 991-0057 Fax: (818) 991-1281

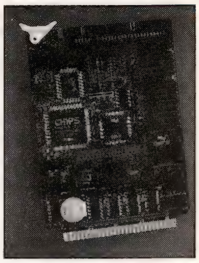


CIRCLE 362

T-Cubed Systems

386 /486 Rugged CPU Boards

VersaLogic's new 386/486 products are rugged, small (4.5"x6.5"), and fully MS-Dos compatible. These STD 32 single board computers can be used alone, or as part of an expanded system in a rugged, compact rack small enough to fit in your hand. 32-bit software support means you can run advanced operating systems (Windows, etc.).

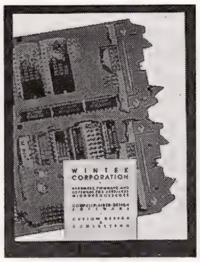


CIRCLE 363

VERSALOGIC

Microcomputer Modules & CAD

Catalog describes 6800 and 6809 single-board computers, input /output interfaces, debuggers, compilers and assemblers; plus CAD software for IBM PC's

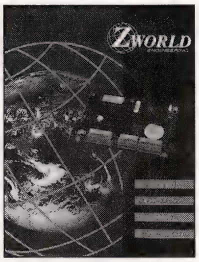


CIRCLE 364

Wintek Corporation

C-Programmable Controllers

Saves time. Save money. Our miniature controllers are ideal for control, test or data acquistion applications a mix of analog/digital I/O, relays, RS232/485 serial ports, & programmed with DynamicC™. From $159, Qty. 1. (916) 757-3737, or Fax: (916) 753-5141. For 24 Hr. DataSheets, call from YOUR Fax: (916) 753-0618



CIRCLE 365

. Z-World Engineering

YOUR CATALOG COULD BE HERE

For information regarding this section, circle the number below, or call your local sales representative. Our SALES Offices are listed on page 168.

?

CIRCLE 366

YOUR COMPANY NAME

Turn your
excess inventory
into a substantial tax break
and help send needy
kids to college.

Call for your
free guide
to learn how donating your
slow moving inventory
can mean a generous
tax write off
for your company.

Call (708) 690-0010
Peter Roskam
Executive Director

EAL

P.O. Box 3021, Glen Ellyn, IL 60138
FAX (708) 690-0565

Excess inventory today...
student opportunity tomorrow

"The marketing plan said we'd double in size, so Ed in Purchasing—remember Ed?—he got this great volume discount on office furniture."
DON

ELECTRONIC DESIGN

DIRECT CONNECTION ADS

Products/Services Presented By The Manufacturer.
To Advertise, Call KIMBERLY STANGER At 201/393-6080

PROTO EXPRESS

Best Value in the World for

Polyimide and FR4
Commercial & Milspec
MULTILAYER PROTOTYPES

1 to 5 day turns ☐ 1 to 12 layers

5 DAY TURN PRICES FOR FR4 BOARDS

SINGLE SIDED

PIECES		2	5	10
SQUARE INCH UP TO	15	$233	$311	$389
	30	264	352	441
	60	311	414	519
	90	358	476	608
	120	385	519	649

DOUBLE SIDED

PIECES		2	5	10
SQUARE INCH UP TO	15	$292	$389	$487
	30	330	441	552
	60	389	519	650
	90	448	597	747
	120	486	649	812

3 & 4 LAYERS

PIECES		2	5	10
SQUARE INCH UP TO	15	$639	$851	$1065
	30	724	965	1207
	60	853	1135	1420
	90	980	1305	1632
	120	1044	1420	1774

5 & 6 LAYERS

PIECES		2	5	10
SQUARE INCH UP TO	15	$787	$1049	$1312
	30	891	1189	1487
	60	1049	1399	1750
	90	1207	1597	2012
	120	1311	1750	2187

7 & 8 LAYERS

PIECES		2	5	10
SQUARE INCH UP TO	15	$935	$1247	$1560
	30	1059	1414	1768
	60	1137	1663	2080
	90	1434	1912	2391
	120	1559	2079	2599

ALL OTHERS - CALL FOR QUOTE

EXTRAS
- Photoplotting
- Testing
- Gold Contacts - $50
- 25% - Below 8 Mil
- Thickness Variation
- SMOBC & LPI - $50

Prices effective January 1, 1993

Capabilities
- Buried & Blind Vias
- Polyimide Multilayer
- Full body & bondable gold
- Carbon Paste
- Tin nickel burn-in boards
- SMT - SMOBC
- Up to 22 layers
- Impedance control boards
- UL listed

DISCOUNTS: **10%** COD

5% CREDIT CARD SALES

Call Ken Bahl

1108 West Evelyn Avenue
Sunnyvale, California 94086

PHONE: 408/735-7137
FAX: 408/735-1408
MODEM: 408/735-9842

PROTO EXPRESS **CIRCLE 410**

In-Circuit Emulators For

8051
683xx
68HC11
68HC16

See EEM 93/94
Pages D 1304-1309

- Rental and 10-day trials available.
- Full Source-level Debugger w/*complete* C-variable support.
- Supports virtually all members of the 8051, 68HC11, 68HC16 and 68300 families.

CALL OR WRITE FOR FREE DEMO DISK!

NOHAU CORPORATION
51 E. Campbell Avenue
Campbell, CA 95008
FAX (408) 378-7869
(408) 866-1820

Call 408-378-2912
Nohau's 24-hour information center to receive info via your FAX

NOHAU CORPORATION **CIRCLE 408**

Turn your
excess inventory
into a tax break
and help send needy
kids to college.

Call for your
free guide
to learn how donating your
slow moving inventory
can mean a generous
TAX WRITE OFF
for your company.

"I'm a vice president because I sold 22,000 gizmos this year. How'd you become a v.p.?"
"I made a great deal on the 200,000 gizmos you didn't sell last year."

Call (708) 690-0010

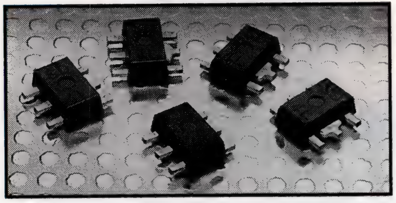
EAL

P.O. Box 3021, Glen Ellyn, IL 60138
Fax (708) 690-0565

Excess inventory today...student opportunity tomorrow

DIRECT CONNECTION ADS

Precise Step-Up Switching Regulators



High-precision S-8435 / 6/7/8 Series CMOS step-up switching voltage regulators offer extremely low current consumption (5.0µA typical), minimum 0.9V operating voltage and maximum 30mA output current. Output voltages depend on the model. An ultra-small 5-pin SOT-89-5 package makes them ideal for portable battery-powered devices.

Seiko Instruments USA, Inc.,
Semiconductor Products Group,
1130 Ringwood Court,
San Jose, Ca. 95131 (408) 433-3208.

SEIKO INSTRUMENTS **CIRCLE 412**

RELIABILITY PREDICTION SOFTWARE

ARE YOUR PRODUCTS RELIABLE?

The RelCalc 2 Software Package automates the reliability prediction procedure of MIL-HDBK-217, or Bellcore, allowing quick and easy reliability analysis of electronic products on your PC. Say goodbye to tedious, time consuming, and error prone manual methods!

- NEW UPDATE! VERSION 3.1 now available.
- User friendly: pop-up menus, hypertext help.
- Very easy to learn and use; quick data entry.
- Part library for rapid recall of part data.
- Global editing functions for what-if? trials.
- Reports which clearly organize results.
- Save time & money as you design for quality.
- Try our Demo Package today for $25.

T-Cubed Systems, 31220 La Baya Drive,
Suite 110, Westlake Village, CA 91362
CALL: (818) 991-0057 FAX: (818) 991-1281

T-CUBED SYSTEMS **CIRCLE 413**

"Is the TERROR

of BIG S-L-O-W 8051 software stalking your job security?"

Take some of the bytes out of your bloated code! Call Franklin Software, the first and last word in *performance crafted* quality for your 8051 and 80C166 software projects!

FRANKLIN SOFTWARE, INC

"Strike back - Release VI is available now!"
tel: (408) 296-8051 fax: (408) 296-8061

FRANKLIN SOFTWARE, INC. **CIRCLE 404**

TELEPHONE LINE SIMULATORS

- 2,4 or 8 simulated telephone lines for worst-case testing or demo of your telecom products
- DTMF / pulse dialing, ring signal, battery feed and call progress tones
- Caller-ID signals with RS232C programming
- Distinctive ring features
- New -- LED displays of loop current, line voltage (DC or AC-RMS), and dialed numbers
- New -- Pay phone interface with floating power supply

PO Box 5597
Beaverton, OR 97006
Phone 503-693-6982
Fax: 503-693-9742

MICRO SEVEN INC. **CIRCLE 416**

Advin

We have programming support for these, now:

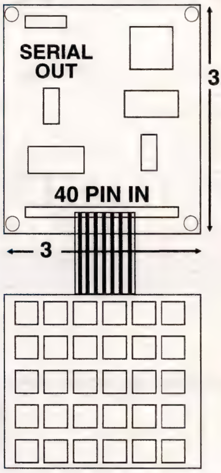
- Intel FX740,FX780 • Altera MAX 7064, 7128
- AMD 29F010, 29F040, 16R8-4, MACH435
- Xilinx 1736D,1765D • Moto HC711,HC705
- Intel 87C196 KD,KR,JR,MC • Lattice pLSI
- Atmel 29C040 • WSI PSD-4XX,-5XX,PAC
- All packages: PLCC,PGA,QFP,TQFP,SOIC

For immediate support, please call
800-627-2456 FAX: (408) 736-2503

ADVIN **CIRCLE 401**

BUILD YOUR OWN PC BASED KEYPAD

KEYPAD ENCODER



$59.95
(PAD NOT INCLUDED)

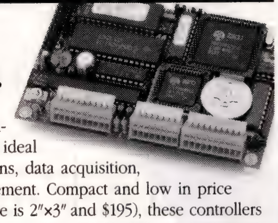
ENCODES UP TO 340 KEYS (20X17) OUTPUTS X & Y COORDINATES

INCLUDES FREE PC TEST PROGRAM

PHASE BUSINESS SYS.
460 S. ARROWHEAD
SAN BERNARDINO
CA. 92408-1309
TEL.909-889-2233
FAX 909-885-8286

PHASE BUSINESS SYS. **CIRCLE 421**

Low Cost Miniature Controllers



Save time. Save money.

Our wide range of C-programmable miniature controllers are ideal for control applications, data acquisition, and test and measurement. Compact and low in price (the Little PLC™ above is 2″×3″ and $195), these controllers are programmed with our easy-to-use Dynamic C™ development system. Our controllers feature digital I/O, ADCs and DACs, relays and solenoid drivers, RS232 and RS485 serial ports, battery-backed memory and time/date clock, LCDs, keypads, enclosures and more!

24-Hour AutoFax 916.753.0618. Call from *your* FAX.

1724 Picasso Ave.
Davis, CA 95616
916.757.3737
916.753.5141 FAX

ZWORLD ENGINEERING

Z-WORLD ENGINEERING **CIRCLE 415**

NoiseKen®

EMI NOISE SENSOR

MODEL FVC-777

- COMPLETELY PORTABLE
- RECHARGEABLE FOR COLDLESS TESTING
- EXTREMELY SIMPLE TO USE
- NO SHIELDED ROOM NECESSARY
- SIMULTANEOUS 8 SPECTRA MEASUREMENT

100kHz~1000MHz

- THREE NEAR FIELD PROBES INCLUDED
- VERY AFFORDABLE
- SAVES TIME & MONEY

IDEAL PRETESTER FOR **FCC CISPR VDE**

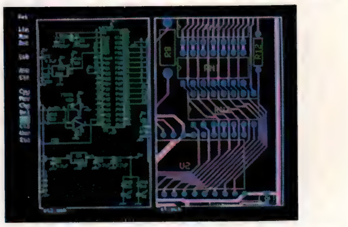
For all your EMI/EMC simulator and sensor needs, please contact
U.S.A. WATAHAN NOHARA INTERNATIONAL, INC.
TEL(800)366-3515

ESD/IMPULSE NOISE/VOLTAGE DIP/LIGHTNING SURGE

NOISEKEN **CIRCLE 409**

HiWIRE II

Schematic and PCB Software



With support for expanded and extended memory, HiWIRE II can handle your most demanding schematic and PCB designs. The unique HiWIRE II editor allows you to display and edit schematics and PCBs simultaneously, using the same commands for each. HiWIRE II is $995 and is guaranteed.

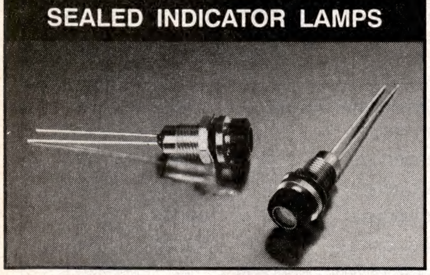
WINTEK®

Wintek Corporation
1801 South Street
Lafayette, IN 47904

(800) 742-6809 or (317) 448-1903

WINTEK **CIRCLE 414**

MINIATURE PANEL MOUNTING SEALED INDICATOR LAMPS



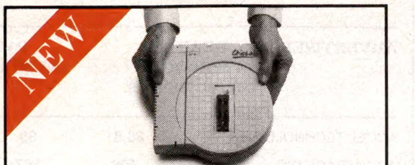
The Oxley MIL50 series indicators are designed to fit into a 5mm mounting hole. Ideal for portable instruments, consoles indoor/outdoor applications. Features include:

* Sunlight readability & NVG Compatibility
* Electrostatic screen for protection against emi
* Clear or Diffused lens
* Wide range of colors (red, yellow, green, and blue)

Contact the Sales Department at (203) 488-4135 for further information.

Oxley Inc.
25 Business Park Dr., Brandford, CT 06405

OXLEY INC. CIRCLE 420



ChipLab™

- Programs PLDs, PROMs, and EPROMs and microcontrollers up to 48 pins
- Algorithm updates available via electronic bulletin board

Special Introductory Price
32-pin version: $895
48-pin version: $1495

To order, call:
1-800-3-DataIO, Ext. 904
(1-800-332-8246)

Also distributed by:
Promark Technology West
(1-800-227-3345)
JDR Microdevices
(1-800-538-5000)

DATA I/O

DATA I/O CIRCLE 402

FREE!
120 Page Catalog

"Optics for Industry"

ROLYN OPTICS supplies all types of "Off-the-Shelf" optical components. Lenses, prisms, mirrors, irises, microscope objectives & eyepieces plus hundreds of others. All from stock. Rolyn also supplies custom products & coatings in prototype or production quantities. Write or call for our free 120 page catalog describing products & listing off-the-shelf prices. **ROLYN OPTICS CO.**, 706 Arrowgrand Circle, Covina, CA 91722, (818) 915-5707 & (818) 915-5717. FAX: (818) 915-1379.

ROLYN OPTICS CIRCLE 411

DC/CAD
introducing. . .
THE TERMINATOR
Super High Density Router
(Complete with Schematic & PCB EDITOR)

Features the following powerful algorithm & capability:
* Rip - up and Retry
* Pre-routing of SMT components
* Real-Time via minimization
* Real-Time clean up passes
* User defined strategies
* Window 3.0 capability as DOS Task
* 1-mil Autoplacer and Autopanning
* Two-way Gerber and DXF
* Automatic Ground Plane w/Cross-Hatching
* Complete w/Schematic & Dolly Libraries
* Optional simulation capability & enhanced mode for 386 users

CALL FOR FREE DEMO
Price Range:$195-$2500
*Special promotional offer is currently available

PCB LAYOUT SERVICE AT LOW COST
LEASE PROGRAM & SITE LICENSE AVAILABLE

1771 State Highway 34, Farmingdale, N.J. 07727
(908) 681-7700 * (908) 681-8733 (FAX)
**DC/CAD . . . The performance value leader for the demanding entrepreneur.*

DESIGN COMPUTATION CIRCLE 422

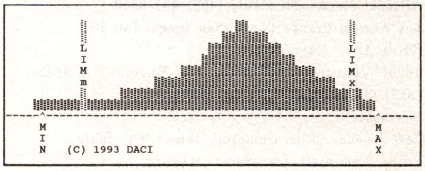
GET *DSPeed!*

TMS320C5X 40 MIPS DSP
TMS320C2X 12.5 MIPS DSP
In-Circuit Emulators
Featuring:
- TI compatible HLL Debugger
- 4K deep real-time trace buffer
- Zero wait-state overlay memory
- Multiple hardware breakpoints

MACROCHIP RESEARCH INCORPORATED
1-800-783-9546
FAX 214-245-1005

MACROCHIP RESEARCH CIRCLE 419

BEAT THE ODDS with the
WORST CASE ANALYZER ™



- Exclusive probability-based risk assessment software
- Confirm the design integrity of amps, filters, power supplies, interface, PLLs, medical, flight, video, optics, mechanics, heat transfer, etc.
- Solve design equations for min, avg, max performance, sensitivites, and probability of failure.
- Easy to install and use; DOS format
- Used by engineering divisions of major Fortune 500 firms Companion Risk Master TM program for design managers also available.

WORST CASE ANALYZER ™$595.00 PER COPY
RISK MASTER™ $125.00 PER COPY

Design / Analysis Consultants, Inc.
10014 N. Dale Mabry, Tampa, Fl. 33618
Tel 1-800-780-8331 FAX 813-961-2395

DESIGN/ANALYSIS CIRCLE 403

DECISION IS YOURS!
as to who gives you the best value?

5 DAY TURN
PRINTED CIRCUIT BOARDS
TWO-PIECE PRICES

LAYERS	1&2	3&4
SQUARE 60	$300	$725
INCH 90	$350	$800
UP TO 120	$400	$875

• 5 Pieces x 1.33 • 10 Pieces x 1.66
EXTRAS: Photoplotting • Testing • Gold

SERVICES:
- 1 TO 5 DAY TURN
- UL Approved
- Single/Double/Multi-layer
- Prototype and Production
- Instant Quotes
- Gerber/AutoCAD/HPGL/P-CAD
- SMOBC and LPI
- Electrical Testing

DESIGN
- Extensive expertise in single, double & multi-layer circuit design
- Latest design tools and techniques to help you identify ways to reduce layers & simplify assembly
- Capability to suggest design alternatives to improve fabrication efficiency

PHOTOPLOTTING PRICES

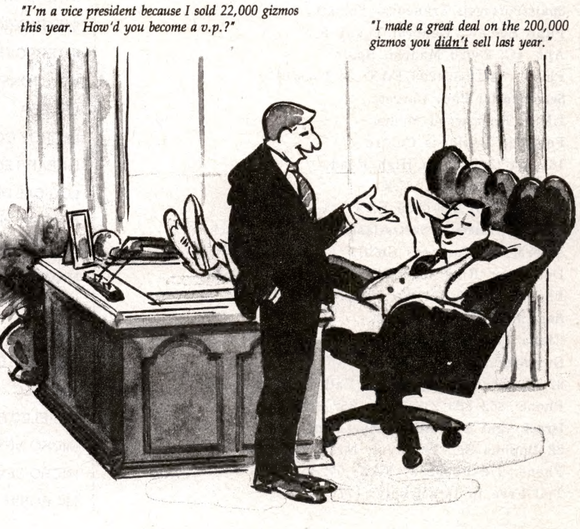
FILMSIZE	MASTER
8 x 10	$8
10 x 12	$10
11 x 14	$12
12 x 18	$14
16 x 20	$23
20 x 24	$30
24 x 36	$50

CALL US TODAY AT
Accutrace Inc. 1-800-600-6611
SAVE EVEN MORE WITH FULL SERVICE

ACCUTRACE INC. CIRCLE 400

Turn your **excess inventory** into a tax break and help send needy **kids to college.**

Call for your **free guide** to learn how donating your slow moving inventory can mean a generous **TAX WRITE OFF** for your company.


"I'm a vice president because I sold 22,000 gizmos this year. How'd you become a v.p.?"
"I made a great deal on the 200,000 gizmos you didn't sell last year."

Call **(708) 690-0010**

EAL
P.O. Box 3021, Glen Ellyn, IL 60138
Fax (708) 690-0565

Excess inventory today...student opportunity tomorrow

ELECTRONIC DESIGN

Chairman and CEO: Sal F. Marino
President and COO: Daniel J. Ramella
President, Electronics Group: James D. Atherton

Advertising Sales Staff

Publisher: John R. Carroll
Hasbrouck Heights, NJ; (201) 393-6060
National Sales Manager: Russ Gerches
Hasbrouck Heights, NJ; (201) 393-6045
General Manager, European Operations: John Allen
36 The Green, South Bar Banbury,
Oxford 0X16 9AE, U.K.
Phone: 44 (0)295-271003 FAX: 44 (0)295-272801
Hasbrouck Heights: Judith L. Miller, Jami Radow
Sales Asst.:Jessica Berni
611 Route #46 West, Hasbrouck Heights, NJ 07604;
Phone: (201) 393-6060TWX: 710-990-5071
Boston & Eastern Canada: Ric Wasley
400 Fifth Ave., Waltham, MA 02154;
Phone: (617) 890-0891 FAX: (617) 890-6131
Colorado: Lou Demeter (408) 441-0550
Chicago/Midwest: Mark Kearney
Sales Assistant: Susan Johnson
180 N. Stetson Ave., Suite 2525
Chicago, IL 60601;
(312) 861-0880 FAX: (312) 861-0874
Arizona: James Theriault (408) 441-0550
Los Angeles/Orange County/San Diego: Ian Hill
Sales Asst: Patti Kelly
16255 Ventura Blvd., Suite 200 Encino, CA 91436;
(818) 990-9000 FAX: (818) 905-1206
San Jose:
Jeff Hoopes, Lou Demeter, James Theriault
Sales Administrator: Sarena Owens
2025 Gateway Pl., Suite 354 San Jose, CA 95110;
Phone: (408) 441-0550
FAX: (408) 441-6052 or (408) 441-7336
Pacific N.W. & Western Canada: Jeff Hoopes (408) 441-0550
Texas/Southeast: Bill Yarborough
12201 Merrit Dr., Suite 220, Dallas, TX 75251;
(214) 661-5576 FAX: (214) 661-5573
Direct Connection Ads & DAC Sales Representatives:
Kim Stanger (201) 393-6080
Betsy Tapp (201) 393-6075
Recruitment/Classified: Lois Walsh
(216) 696-7000, ext. 2359 Fax: 216-696-8207
Netherlands, Belgium: Peter Sanders, S.I.P.A.S.
Rechtestraat 58 1483 Be De Ryp, Holland
Phone: 312 997 1303 Fax: 312 997 1500
France: Fabio Lancellotti
Defense & Communication
10 Rue St. Jean 75017 Paris France
Phone: 33-142940244 FAX: 33-143872729
Spain/Portugal: Francoise Schmitt
Publi Schmitt General Yague 8,
Apt. 4C, 28020 Madrid, Spain
Phone: 34-1-5554208 FAX: 34-1-5551450
Scandinavia: Paul Barrett
I.M.P. Hartswood Media,
Portfolio Business Centre
161-165 Greenwich High Road,
London SE10 8JA, U.K.
Phone: 44-81-293-0380 FAX: 44-81-858-9584
Germany, Austria, Switzerland: Friedrich Anacker
InterMedia Partners GmbH
Deutscher Ring 40, 42327 Wuppertal, Germany
Phone: 49 202 711 091 Fax: 49 202 712 431
Hong Kong: Tom Gorman,
China Consultant Intl.
Guardian Hse, Ste 905
32 Oi Kwan Road, Happy Valley, Hong Kong
Phone: 852 833 2181FAX: 852 834 5620
Israel: Igal Elan, Elan Marketing Group
22 Daphna St., Tel Aviv, Israel
Phone: 972-3-6952967 FAX: 972-3-268020
Toll Free in Israel only: 177-022-1331

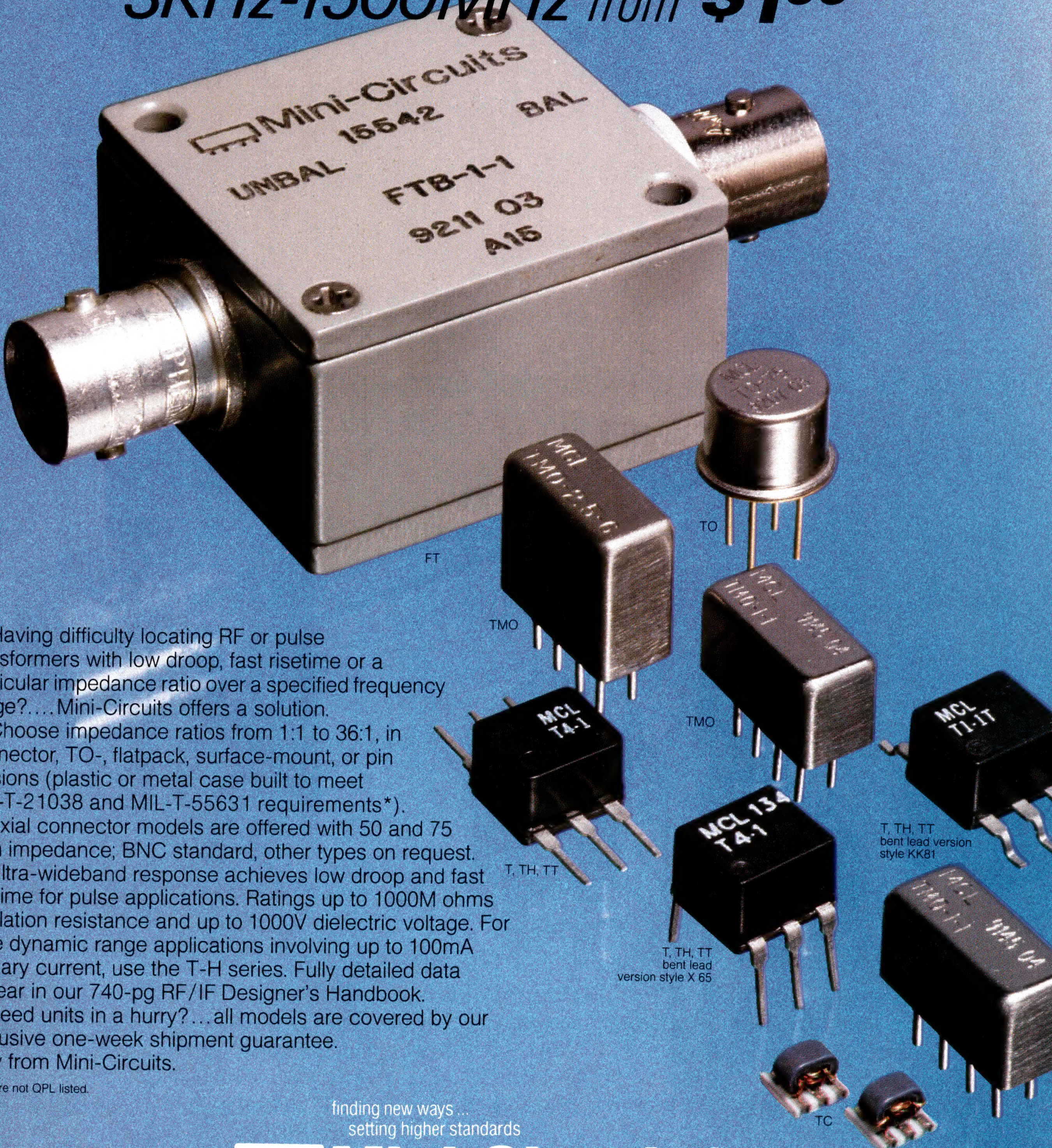
INDEX OF ADVERTISERS

ADVERTISER	READER SERVICE U.S. / OUTSIDE U.S.	PAGE NUMBER
ACCEL TECHNOLOGIES	**80,81**	85
ACCUTRACE INC.	**400**	167
ADVIN SYSTEMS	**401**	167
AMI	**82,83**	102
AMP	**84,85**	14-15
AMPLIFIER RESEARCH	**86,87**	56
ANALOG DEVICES	**88,89**	39
ANCOT CORPORATION	**188,189**	10
ANSOFT	**90,91**	96
APEX	**224,225**	1
APPLIED MICROSYSTEMS	**92,93**	131
BLILEY ELECTRIC CO.	**94,95**	162
BROOKSTONE PRODUCTION	**96,97**	37
BURR-BROWN	**220,221**	51
BURR-BROWN	**254-259**	52-54
CADDOCK ELECTRONICS	**208,209**	68
CADSOFT COMPUTER INC.	**98,99**	94
CASCADE	**181,182**	41
CLASSIFIED	**---**	160
CSPI	**102,103**	126
CYBERNETIC MICROSYSTEMS	**281,282**	18
CYPRESS SEMICONDUCTOR	**---**	Cov4
DALLAS SEMICONDUCTOR	**169,170**	31
DATA I/O	**402**	167
DATAMAN	**194,195**	71
DESIGN ANALYSIS	**403**	167
DESIGN COMPUTATION	**422**	167
DIGI-KEY	**167,168**	9*
DIGITAL EQUIPMENT CORP.	**104,105**	111
DIONICS	**---**	157
ELANTEC	**228,229**	82
EMBEDDED SYSTEMS CONF.	**106,107**	139
EMULATION TECHNOLOGY	**417**	167*
EVERLIGHT	**108,109**	137
FENWAL ELECTRONICS	**110,111**	157
FRANKLIN SOFTWARE	**404**	166
GENTRON	**226,227**	67
HAMAMATSU	**236,237**	76
HARRIS SEMICONDUCTOR	**112,113**	79*
HEWLETT PACKARD	**114,115**	34
HUGHES MICROELECTRONICS	**116,117**	147
INTEGRATED DEVICE TECH.	**---**	125
INTERLINK ELECTRONICS	**118,119**	24
INTERNATIONAL RECTIFIER	**238,239**	26
INTERPOINT	**275,276**	98
KEYSTONE CARBON	**120,121**	22
LAMBDA	**122,123**	80A-H*
LECROY CORPORATION	**242,243**	122
LINEAR TECHNOLOGY	**248,249**	25
LOGICAL DEVICES	**418**	167*
MACROCHIP RESEARCH INC.	**419**	167
MACROTEK	**277,278**	10
MATH WORKS	**124,125**	135
MAXIM	**198-201**	151,153
MAXIM	**273,274**	155
MEGATEL COMPUTER	**265,266**	132
MERITEC	**260,261**	116
MFI-ELECTRO	**126,127**	107
MICRO NETWORKS	**128,129**	8
MICRO SEVEN	**416**	166
MICROSIM	**305,306**	6
MICROSIM CORPORATION	**405**	165
MINI CIRCUITS	**285,256**	11
MINI CIRCUITS	**283,284**	19
MINI CIRCUITS	**136,137**	Cov3
MINI CIRCUITS	**134,135**	119
MINI CIRCUITS	**132,133**	28-29
MOTOROLA SEMICONDUCTOR	**---**	12-13
MOTOROLA SEMICONDUCTOR	**---**	101
NATIONAL INSTRUMENTS	**138,139**	23
NATIONAL SEMICONDUCTOR	**---**	144-145
NCR MICROELECTRONICS	**250,251**	73
NEC CORPORATION	**140,141**	2-3
NOHAU	**216,217**	140
NOHAU CORPORATION	**408**	165
NOISE LABORATORY	**409**	166
ODETICS INC.	**240,241**	146
ORBIT SEMICONDUCTOR	**244,245**	112B-D
ORCAD	**196,197**	Cov2
OXLEY	**420**	167
PCB DESIGN CONFERENCE	**142,143**	149
PENTEK INC.	**144,145**	133
PHASE BUSINESS SYSTEMS	**421**	166
PHILIPS POWER SYSTEMS	**177**	9**
PHILIPS SEMICONDUCTOR	**---**	63
PICO ELECTRONICS	**190,191**	124
PICO ELECTRONICS	**190,191**	150
PORTABLE BY DESIGN	**146,147**	120,152
PROTO EXPRESS	**410**	165
RAYTHEON	**148,149**	87
RAYTHEON	**150,151**	44
ROLYN OPTICS COMPANY	**411**	167
SAMSUNG SEMICONDUCTOR	**267,268**	20-21
SEIKO INSTRUMENTS USA	**412**	166
SELCO/ASAHI	**152,153**	158
SHARP MICROELECTRONICS	**173,174**	32-33
SIEMENS COMPONENTS	**214,215**	128
SILICON SYSTEMS INC.	**187**	95
SILICONIX INC.	**---**	11
SIPEX CORPORATION	**156,157**	161
SMART MODULAR	**230,231**	61
SPARTON ELECTRONICS	**179,180**	148
SPECTRUM SOFTWARE	**232,233**	58
STANFORD RESEARCH	**175,176**	143
SUPERTEX INC.	**234,235**	115
T-CUBED SYSTEMS	**413**	166
TEKTRONIX	**246,247**	86
TEXAS INSTRUMENTS	**206,207**	65*
TEXAS INSTRUMENTS	**202,204**	65**,49
TOSHIBA	**158,159**	138
TRANSERA	**218,219**	93
VACUUMSCHMELZE	**160**	79**
VICOR	**161,162**	121
VIEWLOGIC	**163,164**	47
WAVETEK	**171,172**	88
WINTEK	**414**	166
XILINX	**165,166**	42-43
Z-WORLD ENGINEERING	**415**	166

DOMESTIC ONLY*
INTERNATIONAL ONLY**

RF TRANSFORMERS

Over 80 off-the-shelf models...
3KHz-1500MHz from **$1⁹⁵**



Having difficulty locating RF or pulse transformers with low droop, fast risetime or a particular impedance ratio over a specified frequency range?....Mini-Circuits offers a solution.

Choose impedance ratios from 1:1 to 36:1, in connector, TO-, flatpack, surface-mount, or pin versions (plastic or metal case built to meet MIL-T-21038 and MIL-T-55631 requirements*). Coaxial connector models are offered with 50 and 75 ohm impedance; BNC standard, other types on request.

Ultra-wideband response achieves low droop and fast risetime for pulse applications. Ratings up to 1000M ohms insulation resistance and up to 1000V dielectric voltage. For wide dynamic range applications involving up to 100mA primary current, use the T-H series. Fully detailed data appear in our 740-pg RF/IF Designer's Handbook.

Need units in a hurry?...all models are covered by our exclusive one-week shipment guarantee. Only from Mini-Circuits.

*units are not QPL listed.

finding new ways ...
setting higher standards

Mini-Circuits™

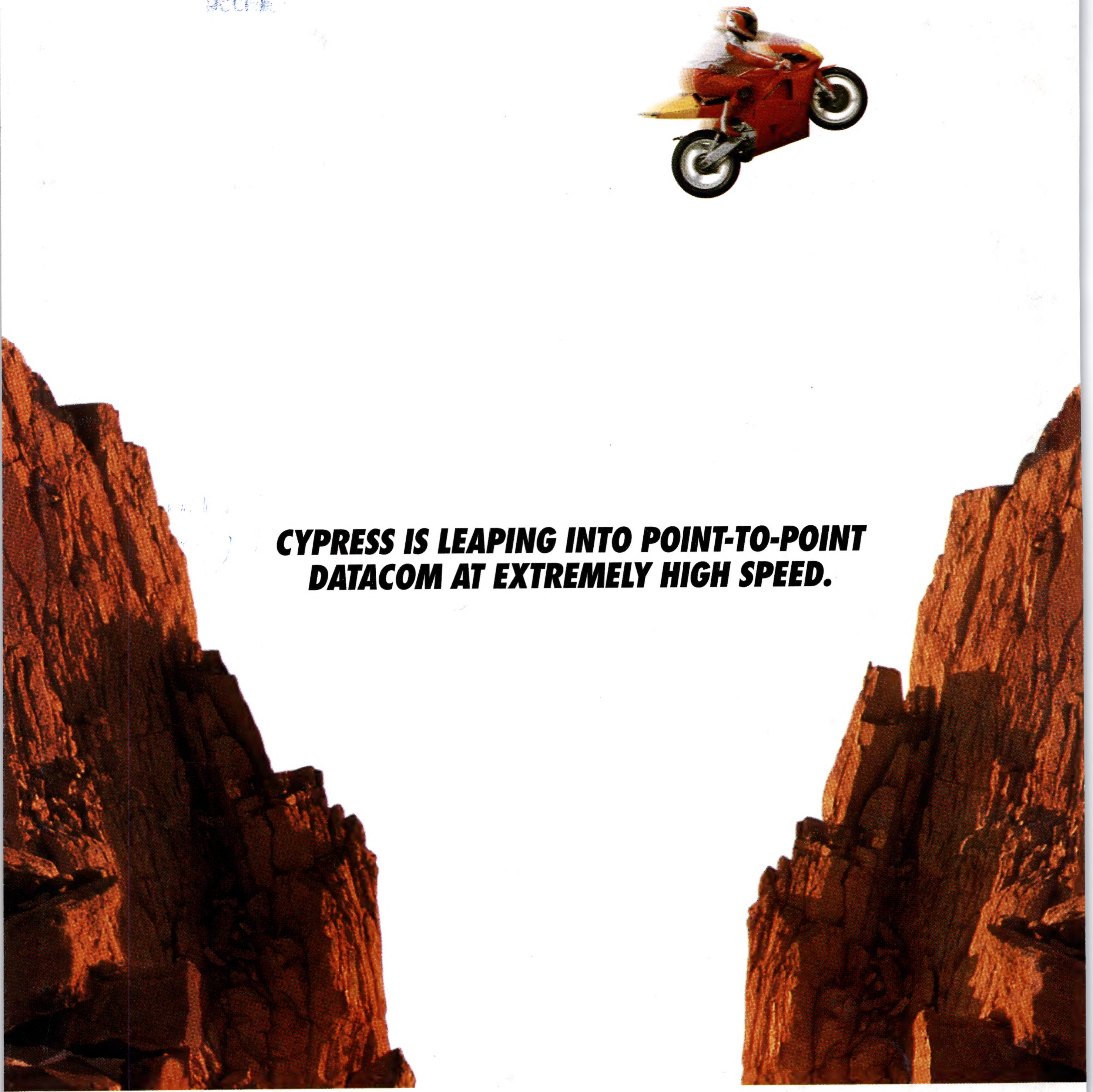
WE ACCEPT AMERICAN EXPRESS AND VISA

P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661
Distribution Centers / NORTH AMERICA 800-654-7949 • 417-335-5935 Fax 417-335-5945 EUROPE 44-252-835094 Fax 44-252-837010

For detailed specs on all Mini-Circuits products refer to • THOMAS REGISTER Vol. 23 • MICROWAVES PRODUCT DIRECTORY • EEM • MINI-CIRCUITS' 740-pg HANDBOOK.

CIRCLE 136 FOR U.S. RESPONSE CIRCLE 137 FOR RESPONSE OUTSIDE THE U.S.

F 71 REV. D


CYPRESS IS LEAPING INTO POINT-TO-POINT
DATACOM AT EXTREMELY HIGH SPEED.

Introducing HOTLink™: The 330 Mbps, Point-to-Point Serial DataCom Chipset from Cypress. HOTLink is a huge leap forward; a transmit/receive chip pair ideal for disk-to-peripheral, server-to-server, serial backplane applications, even video-imaging. Achieve breathtaking speeds up to 330 Mbps—across any distance—via fiber, coax, or twisted pair. Thanks to a uniquely robust BiCMOS architecture, the HOTLink chipset, CY7B923/933, barely sips power—a mere 350 mW for transmitter, 650 mW for receiver. Built-in self-test allows loop back and link integrity diagnostics. In addition, the 8B/10B encoding supports ESCON, Fibre Channel and ATM standards. So get the jump on your competition! **Call for a free data sheet and a poster of this ad. Europe (32) 2-652-0270, ext. 119*, Dept.C3G. Asia: Fax your request to 1-415-940-4343*, Dept. C3G.**

CYPRESS

Or contact us via Europe and Asia fax and telephone numbers listed below. *The international operator can give you your country's specific access code. Europe: Fax (32) 2-652-1504. Telephone Hong Kong: (852) 710-8121. India: (812) 566-630 x-3808. Japan: (81) 423-69-82-11. Korea: (82) 2-576-2111. Singapore: (65) 294-8389. Taiwan: (886) 2-820-53-53. HOTLink is a trademark of Cypress. © 1994 Cypress Semiconductor, 3901 North First Street, San Jose, CA 95134. Telephone 1-408-943-2600, Telex 821032 CYPRESS SNJ UD, TWX: 910-997-0753.